# EXTERNAL TANK AEROTHERMAL DESIGN CRITERIA VERIFICATION VOLUME II

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#### FOREWORD

This final report documents the ET thermal environment generation work performed under the ET Aerothermal Design Criteria Verification study (NAS8-36946). The work was performed for the Thermal Environments Branch (ED-33) of the George C. Marshall Space Flight Center (MSFC).

During the course of the work, significant results and progress were documented in the progress reports submitted each month. The purpose of this report is to summarize the thermal environment generation methodology and to present a comparison with the Rockwell IVBC-3 environments. The report is presented in two volumes. Volume I contains the methodology and environment summaries. Volume II contains the plotted timewise environments comparing the REMTECH results to the Rockwell IVBC-3 results.

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Integrated heat loads contain both aeroheating

and plume convection.

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TABLE 1 MAXIMUM DESIGN HEATING RATE AND LOAD SUMMARY

a) Design Environments for the Nose Spike and 40° Cone Acreage

BODY POINT	COORDIN	INATES	LOCATION	MAX HE	MAX HEATING RATES	/HE/	HEAT LOAD
	$X_T$	$\theta_T$		_	(BTU/ft²sec)	<u>B</u>	$(BTU/ft^2)$
	(in)	(deg)		RI	REMTECH	RI	REMTECH
7000		1	Stag Pt of 1 Ft R. Sphere	2.68	5.75	715.6	920.8
60133	327.66	0.0	30° Conical Nose	14.98	14.98	1840.3	1698.0
60101	328.00	0.0	$\operatorname{Tip}$	11.31	10.93	1593.4	1390.0
60122	328.00	180.0		10.75	10.53	1349.1	1205.0
70300	329.00	0.0		10.21	9.77	1329.2	1090.0
70350	329.00	180.0		9.64	8.99	1147.4	962.3
70375	329.00	270.0		10.87	10.63	1380.5	1158.0
70400	335.00	0.0	10° Nose Cone	4.03	3.77	498.8	439.6
70450	335.00	180.0		3.58	3.40	414.9	370.5
70475	335.00	270.0		4.73	4.26	576.9	503.0
60130	338.00	0.0		3.83	3.57	467.1	411.2
70500	342.24	0.0	40° Cone	15.25	22.07	1434.4	1568.0
70550	342.24	180.0		12.81	21.64	1122.1	1518.0
70575	342.24	270.0		13.50	22.17	1297.6	1603.0
00902	345.50	0.0		18.38	20.48	1593.5	1405.0
70650	345.50	180.0		15.45	20.08	1250.1	1370.0
70675	345.50	270.0		16.28	20.57	1435.6	1429.0
60111	349.00	14.0		22.01	19.41	1574.2	1305.0
70700	354.50	0.0		23.23	18.33	1863.2	1207.0
70750	354.50	180.0		19.52	17.97	1436.5	1184.0
70775	354.50	270.0		20.57	18.41	1643.1	1224.0
60112	357.00	8.0		18.61	17.96	1365.0	1176.0
70800	364.50	0.0		19.02	17.12	1542.7	1108.0
70850	364.50	180.0		15.98	16.78	1217.8	1086.0
70875	364.50	270.0		16.85	17.20	1379.4	1123.0

<del>-</del> Note:

Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this Maximum heating rates pertain to the acroheating only.

b) DESIGN ENVIRONMENTS FOR THE L02 TANK ACREAGE

HEAT LOAD (BTU/ft²)	REMTECH	846.2	839.5	842.1	845.4	848.6	850.3	851.3	850.1	847.8	755.0	833.8	893.8	983.1	850.5	744.5	713.6	755.2	811.5	9.902	701.8	6.989	687.0	647.9	668.3	693.4
HE/	R	817.3	825.5	816.9	845.6	849.1	846.8	808.0	829.8	816.9	750.0	875.0	1016.1	909.2	753.0	764.6	760.3	706.2	819.7	648.6	653.8	734.2	594.5	598.0	597.7	604.4
MAX HEATING RATES (BTU/ft <sup>2</sup> sec)	REMTECH	9.00	8.76	8.78	8.83	8.86	8.88	8.88	8.87	8.84	7.83	8.90	9.42	10.69	9.02	7.87	7.50	8.17	8.55	7.37	7.33	7.22	7.13	6.83	7.03	7.36
MAX )	RI	8.97	8.89	8.83	8.96	8.99	9.00	8.87	9.01	8.93	9.23	11.56	14.34	12.21	9.31	9.30	10.55	8.41	10.01	7.62	7.45	9.62	09.9	92.9	6.78	68.9
LOCATION		LO <sub>2</sub> Tank Acreage																								
ORDINATES	$ heta_T$	0.0	180.0	202.5	225.0	247.5	270.0	292.5	315.0	337.5	357.4	16.9	24.3	31.5	38.7	46.1	65.6	0.1	24.9	31.5	38.1	62.9	0.0	180.0	202.5	225.0
COORD	X <sub>T</sub>	375.10	375.10	375.10	375.10	375.10	375.10	375.10	375.10	375.10	402.50	402.50	402.50	402.50	402.50	402.50	402.50	409.90	409.90	409.90	409.90	409.90	421.30	421.30	421.30	421.30
BODY POINT		70900	70950	70956	70963	69602	70975	70981	70988	70994	60400	60405	60407	60409	60411	60413	60418	60500	60507	60209	60510	60517	71000	71050	71056	71063

Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

b) DESIGN ENVIRONMENTS FOR THE LO2 TANK ACREAGE TABLE 1 CONTINUED

HEAT LOAD	(BTU/ft*)	REMTECH	719.4	734.0	743.1	735.2	716.1	682.8	736.7	723.3	674.1	646.9	649.3	981.9	878.9	822.9	617.4	718.5	859.1	995.1	992.8	782.0	742.9	599.1	557.4	645.6	566.6
HE/	E)	RI	681.2	683.4	2.909	599.9	595.0	648.8	0.669	614.7	670.3	665.2	628.5	940.0	940.1	821.6	626.2	615.4	747.7	937.5	931.1	762.0	6.907	532.9	539.8	557.2	486.5
MAX HEATING RATES	(BTU/ft*sec)	REMTECH	7.61	7.74	7.79	69.2	7.46	7.09	8.27	8.01	6.91	08.9	6.77	11.98	10.64	10.05	6.48	8.06	10.06	12.22	12.22	9.04	8.81	6.17	5.85	08.9	5.80
MAX		RI	7.88	7.93	6.95	6.80	69.9	7.54	8.96	7.00	8.06	8.19	7.35	12.27	12.76	10.78	8.00	7.22	9.99	12.32	12.19	9.95	8.86	5.95	6.30	6.13	5.69
LOCATION			LO <sub>2</sub> Tank Acreage	•			•																				
OORDINATES	•	$ heta_T^{ heta}$	247.5	270.0	292.5	315.0	337.5	3.2	25.8	31.5	37.2	59.8	5.0	23.7	31.5	39.4	58.0	5.9	21.5	26.5	31.5	36.5	57.1	0.0	180.0	270.0	0.0
COORD	1	X (ii)	421.30	421.30	421.30	421.30	421.30	422.30	422.30	422.30	422.30	422.30	432.10	432.10	432.10	432.10	432.10	437.60	437.60	437.60	437.60	437.60	437.60	453.60	453.60	467.40	467.40
BODY POINT			71069	71075	71081	71088	71094	60601	20909	60909	60610	60617	60701	20209	60209	60711	60716	60802	90809	20809	60809	60810	60816	71100	71150	71175	71200

Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $q_{max}$  is listed for  $t \le 95$  seconds. For plume Maximum heating rates pertain to the acroheating only. convection maximum heating rates see Table 14 of this report.

Integrated heat loads contain both acroheating and plume convection.

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Note:

b) DESIGN ENVIRONMENTS FOR THE L02 TANK ACREAGE

BODY POINT	00	ORDINATES	LOCATION	MAX	MAX HEATING RATES	HE	HEAT LOAD
					$(\mathrm{BTU}/\mathrm{ft}^2\mathrm{sec})$	1)	$(\mathrm{BTU}/\mathrm{ft}^2)$
	$X_T$	$\theta_T$	<del></del>				
	(in)	(deg)		RI	REMTECH	RI	REMTECH
	467.40	180.0	LO <sub>2</sub> Tank Acreage	00.9	5.48	521.8	524.3
	467.40	225.0		5.63	6.03	512.3	570.4
	467.40	270.0		5.91	6.44	514.4	612.6
71288	467.40	315.0		5.89	6.38	509.0	615.8
	474.20	23.7		8.76	7.90	617.5	688.1
	474.20	31.5		10.59	10.15	755.9	839.1
	474.20	39.3		9.08	8.92	661.1	729.2
	474.20	53.5		6.23	8.77	511.3	705.1
	512.10	31.5		8.86	7.43	641.5	659.4
	512.60	31.5		89.9	7.40	493.5	657.8
	513.60	0.0		4.97	4.70	410.4	470.5
	513.60	180.0		4.49	4.39	399.3	428.1
	513.60	202.2		4.02	4.58	366.8	447.6
	513.60	225.0		4.03	4.92	362.0	472.0
	513.60	247.5		4.13	5.18	358.2	497.9
	513.60	270.0		4.95	5.33	440.7	513.0
	513.60	292.5		4.24	5.38	361.9	523.7
	513.60	315.0		4.27	5.28	396.6	517.6
	513.60	337.5		4.35	5.04	376.9	499.4
	551.30	37.3		7.39	4.94	518.8	461.3
	551.30	49.0		3.75	3.82	320.9	378.9
	591.40	31.5		5.27	3.22	409.7	338.5
	00.909	0.0		3.22	2.90	280.8	316.1
	00.909	180.0		3.38	2.65	265.7	279.9
	00.909	202.5		2.86	2.80	252.0	295.2

Note: 1) Maximum heating rates pertain to the acroheating only.

Consequently in plume dominated areas between 96 \le t \le \text{126 seconds, \$\dirtit{q}\_{max}\$ is listed for \$t \le 95\$ seconds. For plume convection maximum heating rates see Table 14 of this report

2) Integrated heat loads contain both aeroheating and plume convection.

b) DESIGN ENVIRONMENTS FOR THE L02 TANK ACREAGE

$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$	BODY POINT	Ö	OORDINATES	LOCATION	MAX	MAX HEATING RATES	HE	HEAT LOAD
X <sub>T</sub> θ <sub>T</sub> RI         REMTECH         RI           606.00         225.0         LO <sub>2</sub> Tank Acreage         2.83         3.08         246.6           606.00         247.5         LO <sub>2</sub> Tank Acreage         2.83         3.31         241.9           606.00         247.5         3.01         3.44         341.8         341.8           606.00         315.0         3.05         3.38         282.8           606.00         315.0         3.15         3.15         3.47         248.7           606.00         337.5         3.15         3.18         258.2           606.00         337.5         4.40         2.43         3.13         258.2           632.30         31.5         4.40         2.43         3.13         258.2           632.30         31.5         2.83         3.93         258.3           698.00         0.0         2.25         1.91         1.70         170.6           698.00         2.25.0         1.89         1.91         167.8           698.00         2.25.0         1.89         1.91         167.8           698.00         2.25.0         1.91         1.70         176.8						(BTU/ft <sup>2</sup> sec)	(F	$ m 3TU/ft^2)$
(in)         (deg)         RI         REMTECH         RI           606.00         225.0         LO2 Tank Acreage         2.83         3.08         246.6           606.00         247.5         LO2 Tank Acreage         2.89         3.31         241.9           606.00         270.0         270.0         3.71         3.44         311.8           606.00         270.0         315.0         3.05         3.38         248.7           606.00         337.5         3.05         3.38         258.2           606.00         337.5         4.34         3.13         248.7           632.30         31.5         4.40         2.45         332.4           632.30         46.3         2.83         3.93         258.2           638.00         180.0         2.00         2.40         1.97         208.7           698.00         270.0         2.40         1.59         1.60.8           698.00         270.0         1.89         2.07         165.1           698.00         270.0         2.25         1.89         2.07         165.1           698.00         292.5         2.03         2.13         2.10.8           698.00<		$X_T$	$\theta_T$					
606.00         225.0         LO2 Tank Acreage         2.83         3.08         246.6           606.00         247.5         ————————————————————————————————————		(in)	(deg)		$\mathbf{R}\mathbf{I}$	REMTECH	RI	REMTECH
606.00         247.5         2.89         3.31         241.9           606.00         270.0         3.71         3.44         311.8           606.00         220.5         3.01         3.47         248.7           606.00         315.0         3.05         3.38         258.2           606.00         315.0         3.15         3.18         266.6           606.00         337.5         4.34         3.18         266.6           606.00         337.5         4.34         3.13         266.6           632.30         31.5         4.34         3.13         266.6           632.30         31.5         4.40         2.45         338.3           632.30         31.5         2.83         236.3         236.3           638.00         0.0         2.40         1.59         180.4           698.00         225.0         1.89         2.07         165.1           698.00         225.0         1.89         2.07         165.1           698.00         220.5         2.47         2.16         210.8           698.00         237.5         2.03         2.21         175.3           698.00         237.5 <td>71463</td> <td>00.909</td> <td>225.0</td> <td>LO<sub>2</sub> Tank Acreage</td> <td>2.83</td> <td>3.08</td> <td>246.6</td> <td>313.9</td>	71463	00.909	225.0	LO <sub>2</sub> Tank Acreage	2.83	3.08	246.6	313.9
606.00         270.0         3.71         3.44         311.8           606.00         292.5         3.01         3.47         248.7           606.00         315.0         3.05         3.38         258.2           606.00         337.5         3.15         3.18         266.6           606.00         337.5         3.15         3.18         266.6           632.30         31.5         4.34         3.13         266.6           632.30         46.3         2.40         2.45         332.4           632.30         46.3         2.83         3.03         236.3           632.30         46.3         2.83         3.93         236.3           638.00         20.2         2.25         1.97         208.7           698.00         225.0         1.89         1.91         167.8           698.00         225.0         1.89         1.91         167.8           698.00         225.0         1.89         2.10         167.8           698.00         225.0         1.89         2.10         167.8           698.00         237.5         2.03         1.83         183.0           751.50         31.50 <td>71469</td> <td>00.909</td> <td>247.5</td> <td></td> <td>2.89</td> <td>3.31</td> <td>241.9</td> <td>334.4</td>	71469	00.909	247.5		2.89	3.31	241.9	334.4
606.00         292.5         3.01         3.47         248.7           606.00         315.0         3.05         3.38         258.2           606.00         337.5         3.15         3.18         266.6           606.00         337.5         4.34         3.13         266.6           632.30         31.5         4.40         2.45         332.4           632.30         46.3         2.83         3.93         236.3           632.30         46.3         2.83         3.93         236.3           638.00         31.5         2.95         3.08         236.3           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         227.0         1.89         2.07         167.8           698.00         225.0         1.89         2.07         167.8           698.00         237.5         2.03         1.80.0         1.75.3           698.00         237.5         2.03         1.80.0         1.74         160.0           751.50         1.80.0         2.03         1.74         160.0           751.	71475	00.909	270.0	-	3.71	3.44	311.8	346.8
606.00         315.0         3.05         3.38         258.2           606.00         337.5         3.15         3.18         266.6           632.30         31.5         4.34         3.13         266.6           632.30         36.4         4.40         2.45         338.3           632.30         46.3         2.83         3.93         236.3           632.30         46.3         2.83         3.93         236.3           632.30         46.3         2.83         3.93         236.3           698.00         0.0         2.40         1.97         208.7           698.00         202.5         1.89         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         227.5         1.89         2.16         167.8           698.00         227.5         1.89         2.16         167.8           698.00         237.5         2.03         1.83.0           751.50         315.0         2.03         1.83.0           751.50         180.0         1.74         160.0           759.20         1.80.0         1.97         1.74         160.0 </td <td>71481</td> <td>00.909</td> <td>292.2</td> <td></td> <td>3.01</td> <td>3.47</td> <td>248.7</td> <td>356.5</td>	71481	00.909	292.2		3.01	3.47	248.7	356.5
606.00         337.5         3.15         3.18         266.6           632.30         31.5         4.34         3.13         32.4           632.30         36.4         4.40         2.45         338.3           632.30         46.3         2.83         3.93         236.3           632.30         46.3         2.83         3.93         236.3           632.30         0.0         0.0         2.83         2.30         236.3           698.00         180.0         2.40         1.59         180.4           698.00         202.5         1.89         1.70         170.6           698.00         225.0         1.89         2.07         165.1           698.00         247.5         1.89         2.07         165.1           698.00         275.5         1.89         2.07         165.1           698.00         292.5         1.89         2.16         10.8           698.00         315.0         2.03         1.83.0           751.50         315.0         2.03         1.83.0           751.50         180.0         1.74         1.60.0           751.50         270.0         1.74         1.75	71488	00.909	315.0		3.05	3.38	258.2	352.8
632.30         31.5         4.34         3.13         332.4           632.30         36.4         4.40         2.45         338.3           632.30         46.3         2.83         3.93         236.3           632.30         46.3         2.85         3.08         239.7           698.00         0.0         2.16         1.97         208.7           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         225.0         1.89         1.91         167.8           698.00         225.0         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         237.5         1.97         2.19         168.0           698.00         337.5         2.03         1.74         160.0           751.50         180.0         1.76         1.74         160.0           751.50         270.0         1.66         1.75         148.5           751.50         270.0         1.67         1.74         160.0           751.50         270.0	71494	00.909	337.5		3.15	3.18	266.6	338.9
632.30         36.4         4.40         2.45         338.3           632.30         46.3         2.83         3.93         236.3           632.30         31.5         2.95         3.08         239.7           698.00         0.0         2.16         1.97         208.7           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         247.5         1.89         2.07         168.0           698.00         247.5         1.89         2.07         168.0           698.00         247.5         1.89         2.07         168.0           698.00         247.5         2.16         210.8           698.00         315.0         2.03         1.75         175.3           698.00         315.0         2.03         2.12         175.3           751.50         31.5         2.51         2.88         215.6           751.50         180.0         1.76         1.74         160.0           751.50         31.5         2.10         2.28         148.5           759.20         31.5         2.10	61309	632.30	31.5		4.34	3.13	332.4	326.2
632.30         46.3         2.83         3.93         236.3           673.90         31.5         2.95         3.08         239.7           698.00         0.0         2.16         1.97         208.7           698.00         180.0         2.40         1.59         180.4           698.00         202.5         1.89         1.70         170.6           698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         270.0         2.47         2.16         210.8           698.00         315.0         2.47         2.16         165.1           698.00         315.0         2.03         183.0           715.80         31.5         2.03         183.0           751.50         0.0         1.76         1.74         160.0           751.50         270.0         1.66         1.75         148.5           751.50         270.0         1.66         1.79         172.6           759.20         270.0         1.66         1.79         172.6           759.20         270.0         1.66         1.79	61311	632.30	36.4		4.40	2.45	338.3	264.9
673.90         31.5         2.95         3.08         239.7           698.00         0.0         2.16         1.97         208.7           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         225.0         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.16         210.8           698.00         315.0         2.03         168.0           715.80         31.5         2.03         175.3           751.50         0.0         1.76         1.74         160.0           751.50         270.0         1.66         1.55         148.5           751.50         31.5         2.51         2.28         172.6           751.50         31.5         2.10         1.74         160.0           751.50         270.0         1.76         1.74         160.0           759.20         33.8         2.10         1.79         172.6           759.20         33.8         2.20         1.79	61313	632.30	46.3		2.83	3.93	236.3	387.8
698.00         0.0         2.16         1.97         208.7           698.00         180.0         2.40         1.59         180.4           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         168.0         168.0           715.80         31.5         2.03         183.0         175.3           751.50         180.0         1.76         1.74         160.0           751.50         270.0         1.66         1.55         148.5           759.20         31.5         2.10         2.28         186.1           759.20         33.8         2.10         2.28         186.1           759.20         33.8         2.10         2.28         263.7	61409	673.90	31.5		2.95	3.08	239.7	306.0
698.00         180.0         2.40         1.59         180.4           698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         315.0         2.03         1.80.0         183.0           715.80         31.5         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.74         160.0           751.50         270.0         1.66         1.79         172.6           759.20         33.8         2.10         2.28         186.1           759.20         33.8         2.10         2.28         186.1           759.20         33.8         2.10         2.28         263.7	71500	00.869	0.0		2.16	1.97	208.7	215.5
698.00         202.5         1.91         1.70         170.6           698.00         225.0         1.89         1.91         167.8           698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         2.12         175.3           698.00         315.0         2.03         183.0           715.80         31.5         2.10         2.03         183.0           751.50         0.0         1.76         1.74         160.0           751.50         270.0         1.66         1.55         148.5           751.50         31.5         2.10         2.28         186.1           759.20         31.5         2.10         2.28         186.1           759.20         33.8         2.10         2.28         263.7	71550	00.869	180.0		2.40	1.59	180.4	186.9
698.00         225.0         1.89         1.91         167.8           698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         175.3         175.3           698.00         31.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         180.0         1.76         1.74         160.0           751.50         270.0         1.66         1.55         148.5           759.20         31.5         2.10         2.28         186.1           759.20         33.8         2.20         1.79         172.6           759.20         270.0         1.37         2.28         186.1           759.20         33.8         2.50         2.20         1.86.1           759.20         270.0         2.20         2.20         1.86.1           759.20         2.20         2.20         2.20         1.48.5           759.20         2.20 </td <td>71556</td> <td>698.00</td> <td>202.5</td> <td></td> <td>1.91</td> <td>1.70</td> <td>170.6</td> <td>197.7</td>	71556	698.00	202.5		1.91	1.70	170.6	197.7
698.00         247.5         1.89         2.07         165.1           698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         183.0           698.00         31.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.74         160.0           751.50         270.0         1.66         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         2.28         2.28         2.63.7	71563	00.869	225.0		1.89	1.91	167.8	210.4
698.00         270.0         2.47         2.16         210.8           698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         2.12         175.3           698.00         337.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         263.7           759.20         33.8         2.23         263.7	71569	00.869	247.5		1.89	2.07	165.1	225.0
698.00         292.5         1.97         2.19         168.0           698.00         315.0         2.03         175.3           698.00         337.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71575	00.869	270.0		2.47	2.16	210.8	234.5
698.00         315.0         2.03         2.12         175.3           698.00         337.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71581	00.869	292.5		1.97	2.19	168.0	242.6
698.00         337.5         2.10         2.03         183.0           715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71588	00.869	315.0		2.03	2.12	175.3	241.0
715.80         31.5         2.51         2.88         215.6           751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71594	00.869	337.5		2.10	2.03	183.0	231.6
751.50         0.0         1.76         1.74         160.0           751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	61509	715.80	31.5		2.51	2.88	215.6	301.6
751.50         180.0         1.66         1.55         148.5           751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71600	751.50	0.0		1.76	1.74	160.0	182.6
751.50         270.0         1.97         1.79         172.6           759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71650	751.50	180.0		1.66	1.55	148.5	164.2
759.20         31.5         2.10         2.28         186.1           759.20         33.8         3.52         2.28         263.7	71675	751.50	270.0		1.97	1.79	172.6	198.3
759.20 33.8 3.52 2.28 263.7	61609	759.20	31.5		2.10	2.28	186.1	241.8
	61610	759.20	33.8		3.52	2.28	263.7	235.1

Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both acroheating and plume convection.

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b) DESIGN ENVIRONMENTS FOR THE L02 TANK ACREAGE TABLE 1 CONTINUED

	COORD	OORDINATES	LOCATION	MAX	$MAX HEATING RATE$ $(BTU/ft^2sec)$	HE.	${ m HEAT~LOAD} \ ({ m BTU/ft}^2)$
	Ϋ́	θπ					
	(in)	(deg)		RI	REMTECH	RI	REMTECH
61611	759.20	36.0	LO <sub>2</sub> Tank Acreage	2.02	1.88	181.4	212.8
61613	759.20	45.1		1.65	1.76	147.8	202.2
61709	762.20	31.5		2.03	1.55	150.6	187.2
61809	773.70	31.5		2.25	2.59	169.6	260.1
61909	786.20	31.5		2.36	2.14	191.7	225.1
62009	793.10	31.5		2.88	2.43	216.5	258.9
71700	796.50	0.0		2.10	1.45	160.7	154.0
71750	796.50	180.0		2.21	1.29	164.1	138.5
71756	796.50	202.5		2.21	1.29	162.8	145.3
71763	796.50	225.0		2.21	1.44	161.6	162.2
41769	796.50	247.5		2.21	1.44	160.2	162.2
71775	796.50	270.0		2.58	1.50	192.4	167.5
71781	796.50	292.5		1.92	1.51	139.3	171.6
71788	796.50	315.0		1.92	1.47	144.7	169.8
71794	796.50	337.5		2.05	1.47	153.3	163.8
62109	827.10	31.5		2.86	2.43	215.6	259.1
71800	841.50	0.0		2.15	1.43	168.7	151.1
71850	841.50	180.0		2.18	1.27	161.5	135.7
71875	841.50	270.0		2.56	1.48	191.7	164.1

Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $q_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this Maximum heating rates pertain to the aeroheating only. report.

Integrated heat loads contain both aeroheating and plume convection. 7

c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE TABLE 1 CONTINUED

			_	_		_				_				~	~	_	_	_			~	<u>~</u>	20	20	<del></del>
ΑD	(,	REMTECH	/w	167.9	153.8	170.9	467.7	250.2	234.6	180.7	219.4	204.6	192.4	167.2	166.3	156.7	532.0	381.1	1134.5	1134.5	1135.2	1135.8	1134.5	1136.5	165.1
HEAT LOAD	$(\mathrm{Btu}/\mathrm{ft}^2)$	REM	w/o	153.6	140.9	156.1	374.9	205.9	207.1	161.5	185.3	175.5	175.5	154.6	151.5	142.5	424.9	309.7	895.0	895.0	895.4	895.9	895.0	896.5	148.7
HE		RI	w/o	137.1	130.7	107.8	465.3	142.9	147.6	136.6	113.9	201.6	175.2	119.9	131.1	124.4	530.2	242.0	809.9	953.6	887.4	876.9	889.4	856.5	133.3
MAX HEATING RATE	sec)	REMTECH	/w/	1.53	1.44	1.69	7.88	3.25	2.92	1.71	2.53	1.98	1.97	1.43	1.52	1.39	9.20	6.07	21.80	21.80	21.81	21.82	21.80	21.83	1.58
HEATIN	Btu/ft2-sec	REN	o/m	1.45	1.31	1.46	5.92	2.54	2.47	1.47	1.98	1.63	1.63	1.38	1.44	1.30	7.10	4.74	16.18	16.18	16.19	16.19	16.18	16.20	1 49
MAX 1	٠	RI	0/w	1.86	1.95	1.58	9.45	2.00	2.00	1.81	1.61	2.51	2.19	1.33	1.69	2.08	68.6	4.54	16.54	20.32	20.01	19.72	20.29	19.36	1 79
LOCATION				Intertank Acreage																					
ORDINATES	$\theta_T$	(deg)		0.0	180.0	225.0	270.0	292.5	315.0	337.5	247.5	141.3	142.6	31.5	0.0	180.0	270.0	292.5	270.0	270.0	270.5	271.0	270.0	271.6	0
COORDI	$X_T$	(in)	,	884.85	884.85	884.85	884.85	884.85	884.85	884.85	884.86	890.00	900.00	902.00	929.14	929.14	929.14	929.14	961.22	965.22	970.22	970.22	970.22	971.22	073 43
BODY PT				7300	7309	7307	7305	7304	7302	7301	7306	6410	6413	6394	7320	7329	7325	7324	7355	1002	1007	1009	1005	1011	7250

2) Integrated heat loads contain both aeroheating and plume convection.

1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\bar{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

Note:

c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE TABLE 1 CONTINUED

BODY PT	COORDI	ORDINATES	LOCATION	MAX ]	HEATIL	MAX HEATING RATE	HE	HEAT LOAD	AD
	$X_T$	$\theta_T$		<u> </u>	$(\mathrm{Btu}/\mathrm{ft}^2 ext{-sec})$	·sec)		$(\mathrm{Btu}/\mathrm{ft}^2)$	(,
	(in)	(deg)		RI	REN	REMTECH	RI	REM	REMTECH
				o/w	o/w	w/	w/o	o/w	/w
359	973.43	180.0	Intertank Acreage	2.06	1.28	1.40	123.4	136.9	149.1
354	973.43	292.5		5.90	4.42	5.88	321.7	312.9	386.4
352	973.43	315.0		5.24	3.15	4.11	316.1	252.7	307.8
301	983.46	23.5		5.24	3.64	4.75	316.1	364.4	428.6
012	991.07	270.0		11.81	6.71	60.6	512.2	413.3	519.0
365	994.40	270.0		11.76	6.71	9.09	510.3	413.3	519.0
360	1006.65	0.0		1.89	1.41	1.57	139.8	147.4	163.8
368	1006.65	15.0		2.32	1.96	2.56	155.4	195.1	233.5
369	1006.65	19.0		3.41	1.95	2.54	193.0	199.5	237.4
6367	1006.65	29.0		2.83	1.86	2.43	170.0	181.1	214.6
369	1006.65	180.0		2.05	1.27	2.54	122.0	135.9	237.4
364	1006.65	292.5		2.61	3.19	4.17	170.9	252.0	307.0
746	1021.70	13.5		3.22	1.84	2.41	193.2	191.3	225.8
738	1021.70	29.3		2.78	1.97	2.61	173.4	191.1	228.3
387	1025.80	225.0		2.62	2.20	2.84	169.0	198.1	237.3
386	1025.80	247.5		2.10	2.00	2.66	156.6	191.4	229.1
331	1026.00	16.5		3.89	1.95	2.55	253.6	203.2	241.2
380	1038.03	0.0		2.39	1.67	1.93	158.7	170.9	189.2
385	1038.03	270.0		1.31	1.51	1.99	123.4	167.2	197.9
381	1038.03	337.5		2.63	1.94	2.51	175.2	186.5	222.1
400	1069.40	0.0		2.85	2.04	2.61	189.3	186.4	222.9
408	1069.40	15.0		3.97	2.16	2.82	251.0	211.5	252.7

2) Integrated heat loads contain both aeroheating and plume convection.

Note: 1) Maximum heating rates pertain to the aeroheating only.

Consequently in plume dominated areas between 96  $\leq$  t  $\leq$  126 seconds,  $\dot{q}_{max}$  is listed for t  $\leq$  95 seconds. For plume convection maximum heating rates see Table 14 of this report.

c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE TABLE 1 CONTINUED

BODY PT	COORD	OORDINATES	LOCATION	MAX ]	IEATIL	MAX HEATING RATE	HE	HEAT LOAD	4D
	$X_T$	$\theta_T$			Btu/ft2-sec	sec)		$[Btu/ft^2]$	
_	(in)	(deg)		RI	REN	REMTECH	RI	REMTECH	FCH
	,	,		0/w	o/m	w/	w/o	w/o	/w
6409	1069.40	19.0	Intertank Acreage	3.89	2.15	2.80	258.9	210.1	250.9
6407	1069.40	29.0		3.39	2.19	2.80	208.0	192.0	229.2
7409	1069.40	180.0		2.10	1.37	1.72	124.2	141.9	164.9
7406	1069.40	247.5		1.49	1.47	1.88	128.3	159.9	188.2
7405	1069.40	270.0		1.31	1.50	1.92	123.6	159.4	187.5
7404	1069.40	292.5		1.82	1.70	2.19	147.8	177.3	210.4
7401	1069.40	337.5		2.94	2.39	2.84	200.4	205.3	233.8
6395	1074.40	36.0		4.42	2.60	3.39	248.7	210.1	252.7
56282	1080.05	32.5		5.01	2.17	2.77	274.0	189.2	225.9
7420	1102.62	0.0		6.78	4.14	4.72	417.4	311.1	337.4
6429	1102.62	19.0		4.72	3.45	4.51	321.8	262.2	322.3
6427	1102.62	29.0		2.09	2.69	3.44	197.7	204.7	245.5
6424	1102.62	37.7		4.72	2.02	2.58	266.8	181.3	216.2
7429	1102.62	180.0		2.25	1.26	1.68	129.9	142.4	166.6
7427	1102.62	225.0		2.48	2.19	2.81	162.7	195.1	233.9
7426	1102.62	247.5		1.52	1.46	1.87	129.3	158.8	187.0
7425	1102.62	270.0		1.30	1.49	1.91	123.7	158.3	186.3
7424	1102.62	292.5		1.64	1.70	2.19	137.5	176.2	209.1
7422	1102.62	315.0		4.43	2.79	3.57	231.8	213.0	255.9
7421	1102.62	337.5		3.77	2.91	3.75	245.2	236.4	288.1
6286	1111.20	23.5		5.09	3.13	4.08	313.1	274.6	337.8
1100	1111.85	343.0		4.64	3.98	5.31	321.6	333.3	411.6
1107	1111.85	348.0		3.76	3.51	4.66	286.9	308.9	379.9

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this

report.

Integrated heat loads contain both aeroheating and plume convection. 7

c) DESIGN ENVIRONMENTS FOR THE INTERTANK ACREAGE TABLE 1 CONTINUED

ORDIN	COORDINATES	LOCATION	MAX	HEATI	MAX HEATING RATE	HE	HEAT LOAD	40
ı	$\theta_T$		<u> </u>	Btu/ft2-sec)	sec)	)	Btu/ft <sup>2</sup> )	(
_	(deg)		RI	REN	REMTECH	RI	ноатмая	rech
			0/m	o/m	/w	w/o	o/w	/w
	343.0		7.08	4.36	5.57	410.8	335.8	413.4
	348.0		5.55	4.28	5.59	369.1	328.3	409.2
	0.0		8.36	5.59	7.29	447.2	394.9	497.7
	0.081		2.24	1.26	1.67	129.2	142.	165.3
3	25.0		2.22	2.18	2.80	156.9	194.5	233.1
3	47.5		1.50	1.46	1.87	129.1	158.1	186.3
6.4	270.0		1.30	1.49	1.91	124.1	157.6	185.6
	292.5		1.55	1.70	2.17	134.5	174.7	207.2
	315.0		6.25	3.40	4.25	296.6	236.0	314.0
	337.5		4.35	3.19	4.25	260.1	255.5	314.0
	32.5		4.89	4.23	1	276.1	273.	1

Maximum heating rates pertain to the aeroheating only. Note: 1)

Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

Integrated heat loads contain both acroheating and plume convection. 7

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE TABLE 1

${ m HEAT~LOAD} \ ({ m BTU/ft}^2)$	REMTECH	260.1	478.9	137.5	144.4	149.8	151.5	163.2	205.6	366.1	408.1	403.3	361.1	384.8	1	250.2	267.5	198.0	367.7	126.3	131.6	137.5	202.5	243.1	213.0	149.6
HE.	RI	376.8	406.4	101.9	108.8	107.1	102.5	104.5	176.2	240.5	418.6	354.7	371.1	337.1	399.0	215.6	223.9	153.4	312.9	112.2	128.3	98.0	163.7	232.2	208.7	124.0
MAX HEATING RATE (BTU/ $tt^2$ sec)	REMTECH	2.98	6.29	1.34	1.36	1.38	1.43	1.44	2.59	4.19	5.83	5.74	4.18	4.47	1	2.80	3.04	2.07	3.86	1.35	1.39	1.38	2.58	2.92	2.68	1.38
MAX (	rı	5.83	6.47	1.10	1.23	1.19	1.07	1.14	2.41	3.33	6.72	6.32	5.30	4.78	8.45	2.93	3.04	2.05	4.26	1.72	1.74	1.06	2.16	2.89	2.85	1.66
LOCATION		LH <sub>2</sub> Tank Acreage				٠																				
INATES	$ heta_T^{eta}$	23.5	0.0	180.0	225.0	247.5	270.0	292.5	315.0	337.5	12.0	17.0	343.0	348.0	32.5	30.9	30.9	30.9	0.0	180.0	225.0	270.0	315.0	337.5	0.0	270.0
COORDINATES	$\mathbf{X}_T$ (in)	1127.56	1137.29	1137.29	1137.29	1137.29	1137.29	1137.29	1137.29	1137.29	1139.53	1139.53	1139.53	1139.53	1149.99	1151.80	1151.80	1151.80	1167.21	1167.21	1167.21	1167.21	1167.21	1167.21	1201.51	1201.51
BODY POINT		6582	7440	7449	7447	7446	7445	7444	7442	7441	1115	1122	1105	1110	56505	50108	50109	50111	7450	7459	7457	7455	7452	7451	7470	7475

Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{mux}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this 1

Note:

Integrated heat loads contain both aeroheating and plume convection. <del>2</del> report.

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE

AD 2)	REMTECH		126.5	218.4	293.9	127.8	134.3	1	381.6	407.1	291.4	197.9	126.9	135.2	173.1	2.3	176.4	130.6	127.0	131.9	130.0	135.7	135.3	195.7	170.5	
$\frac{\text{HEAT LOAD}}{(\text{BTU}/\text{ft}^2)}$	REM	<u> </u>	12	21	29	12	13	<u>'</u>	38	40		19	12	13	17	17	17	13	12	13	13	13	13	19	17	
H	E	573.8	111.6	219.2	271.7	112.9	123.4	554.3	342.0	361.4	277.4	204.7	112.4	121.5	149.4	172.2	155.4	118.9	105.8	95.3	95.2	120.4	100.4	134.4	127.4	
MAX HEATING RATE (BTU/ft²sec)	REMTECH		1.37	3.27	3.78	1.40	1.36	l	5.06	5.49	3.74	2.28	1.44	1.39	1.88	1.88	1.89	1.15	1.51	1.51	1.35	1.40	1.39	2.54	1.47	
MAX )	RI	11.63	1.84	3.65	4.85	1.88	1.66	10.43	5.19	5.50	4.15	3.53	1.91	1.64	1.23	1.59	2.02	1.65	1.38	1.14	1.14	1.63	1.23	1.76	1.31	
LOCATION		LH <sub>2</sub> Tank Acreage																								
INATES	$ heta_T^{ heta}$	32.5	180.0	0.0	19.0	180.0	260.0	32.5	30.9	30.9	30.9	0.0	180.0	270.0	23.5	23.5	0.0	40.0	180.0	225.0	247.5	270.0	292.5	315.0	337.5	
COORDINATES	X <sub>T</sub> (in)	1204.74	1209.51	1229.96	1229.96	1229.96	1229.96	1269.24	1270.20	1270.20	1270.20	1297.83	1297.83	1297.83	1334.37	1358.90	1359.15	1359.15	1359.15	1359.15	1359.15	1359.15	1359.15	1359.15	1359.15	
BODY POINT		56515	7479	7480	6489	7489	7485	56525	50308	50309	50311	7520	7529	7525	6587	6588	7550	6555	7559	7557	7556	7555	7554	7552	7551	

Note: 1) Maximum heating rates pertain to the aeroheating only.

Consequently in plume dominated areas between 96 \le t \le 126 seconds, qmax is listed for t \le 95 seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE TABLE 1 CONTINUED

(in) 6590 6593 6594 1375.26 6594 1380.41 6595 1383.91 6596 1383.91		LH2 Tank Acreage	,	BEMTECH		
		LH <sub>2</sub> Tank Acreage	RI	TOTAL TOTAL	RI	REMTECH
			2.64	2.21	241.7	184.4
			3.18	2.25	270.1	186.3
			1.09	1.27	139.2	119.9
			1.19	1.26	140.7	119.9
			1.19	1.26	137.6	119.8
04.6661 00000	±0 00.3		4.21	4.15	303.5	348.6
50509 1399.40	40 30.9		4.50	4.52	323.2	376.6
50511 1399.40	40 30.9		2.94	3.07	218.7	265.3
6597   1401.00	00 23.5		0.94	1.26	118.8	119.6
7620 1486.49	19 0.0		2.67	1.84	186.6	170.8
7629 1486.49	180.0		2.00	1.55	112.5	127.4
7625   1486.49	49 270.0		2.47	1.47	147.0	136.9
56534 1591.74	74 32.5		6.11		401.2	1
50808   1593.20	20 30.9		1.77	2.00	178.5	181.1
50809 1593.20	20 30.9		2.15	2.17	199.0	194.9
50811   1593.20	20 30.9		0.93	1.48	105.8	139.6
56535   1597.19	19 32.5		4.21	l	210.7	1
7690   1615.67	67 0.0		2.04	1.46	154.3	144.0
6699 1615.67	67 19.0		3.32	2.34	195.7	212.5
7699 1615.67	67 180.0		1.84	1.56	119.9	129.4
7697   1615.67	67 225.0		1.20	1.46	97.6	128.2
7696   1615.67	67 247.5		1.14	1.31	7.96	123.7
7695   1615.67	67 270.0		2.04	1.65	137.3	141.0
7694   1615.67	67 292.5		1.50	2.78	117.1	208.6
7692 1615.67	67 315.0		1.44	1.69	122.6	150.9

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

2) Integrated heat loads contain both aeroheating and plume convection.

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE TABLE 1 CONTINUED

																												_
HEAT LOAD	(BIU/IL)		REMTECH	151.2	210.4	210.4	136.3	127.8	123.3	122.6	181.0	146.7	145.4	138.9	164.3	251.8	194.2	245.2	175.5	177.3	202.5	232.3	228.7	237.0	214.6	244.8	171.7	197.2
HE	1	•	RI	126.4	213.7	239.5	126.5	113.6	103.4	98.6	125.6	110.5	106.6	214.9	147.9	386.0	197.3	214.3	156.4	159.2	180.9	217.6	203.9	201.2	196.7	235.8	155.9	182.5
MAX HEATING RATE	BTU/tt*sec)		REMTECH	1.42	2.34	2.34	1.30	1.56	1.39	1.32	2.22	1.51	1.30	1.44	2.36	4.61	3.14	2.42	1.38	1.30	1.32	1.46	1.94	1.85	1.27	1.70	1.23	1.88
MAX			RI	1.70	2.60	3.06	1.34	1.73	1.61	1.22	1.87	1.43	1.15	2.63	2.47	4.73	3.39	1.99	1.34	1.38	1.13	3.15	4.24	1.75	1.55	2.77	1.53	1.98
LOCATION				LH2 Tank Acreage																								
NATES		$\theta_T$	(deg)	337.5	23.5	23.5	0.0	180.0	225.0	247.5	292.5	315.0	337.5	309.4	23.5	309.4	23.5	0.0	180.0	225.0	247.5	270.0	292.5	315.0	337.5	0.0	180.0	270.0
COORDINATES		$X_T$	(in)	1615.67	1618.69	1621.96	1743.02	1743.02	1743.02	1743.02	1743.02	1743.02	1743.02	1822.38	1865.39	1868.51	1868.66	1872.20	1872.20	1872.20	1872.20	1872.20	1872.20	1872.20	1872.20	1898.04	1898.04	1898.04
BODY POINT				7691	6603	9099	7760	6922	7977	7766	7764	7762	7761	1401	6614	1404	6617	7830	7839	7837	7836	7835	7834	7832	7831	7850	7859	7855

Integrated heat loads contain both aeroheating and plume convection. 8 Consequently in plume dominated areas between 96  $\leq$  t  $\leq$  126 seconds,  $q_{max}$  is listed for t  $\leq$  95 seconds. For plume convection maximum heating rates see Table 14 of this Maximum heating rates pertain to the aeroheating only.

report.

Note: 1)

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE TABLE 1 CONTINUED

													_													
${ m HEAT~LOAD} \ ({ m BTU/ft}^2)$	REMTECH	212.9	1	256.7	246.7	273.3	285.8	236.8	286.2	230.4	232.3	233.7	231.6	197.5		197.4	197.3	179.1	421.0	445.7	346.6	298.4	389.1	327.9	374.2	335.5
не, (В	RI	214.8	494.0	305.3	263.5	230.9	238.9	202.8	259.6	210.9	222.4	241.1	280.4	192.5	460.9	195.2	193.4	189.4	377.2	391.6	332.6	306.9	398.5	352.0	452.7	341.5
MAX HEATING RATE (BTU/ft $^2$ sec)	REMTECH	1.79	l	5.47	2.97	2.17	2.36	1.63	3.74	1.96	2.03	2.08	2.11	1.07	l	1.07	1.07	2.27	6.50	7.07	4.80	4.65	7.86	7.47	10.60	5.49
MAX ()	RI	2.40	9.83	5.39	3.07	2.08	2.24	1.57	3.51	1.11	1.39	1.75	2.96	0.81	9.39	0.93	0.91	2.32	6.05	6.38	5.03	5.26	8.42	7.62	11.14	5.88
LOCATION		LH <sub>2</sub> Tank Acreage																								
INATES	$ heta_T$	315.0	32.5	304.0	315.0	30.9	30.9	30.9	330.2	23.5	23.5	23.5	23.5	23.5	32.5	23.5	23.5	19.0	30.9	30.9	30.9	289.5	355.0	23.5	19.0	0.0
COORDINATES	$X_T$ (in)	1898.04	1914.24	1914.65	1914.65	1916.00	1916.00	1916.00	1936.79	1955.30	1962.78	1968.39	1971.66	1976.81	1978.74	1980.31	1984.05	1999.54	2028.00	2028.00	2028.00	2031.65	2032.00	2033.00	2036.45	2036.46
BODY POINT		7852	56565	1406	1409	51308	51309	51311	1414	6632	6633	6634	6637	6638	56575	6639	6640	6069	51608	51609	51611	1021	1300	6647	6929	7920

Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $q_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this report.

1

Note:

2) Integrated heat loads contain both aeroheating and plume convection.

d) DESIGN ENVIRONMENTS FOR THE LH2 TANK ACREAGE

HEAT LOAD	$(\mathrm{BTU}/\mathrm{ft}^2)$		REMTECH	174.1	280.9	239.1	263.2	257.2	301.2	257.2	388.4	326.2	376.3	302.2	309.4	167.0	175.0	309.0	331.0	361.7	323.6	507.8	355.5	346.8
HE	1)		RI	155.4	227.1	229.2	266.1	231.9	289.3	280.0	416.7	425.6	438.6	344.0	250.0	152.0	174.3	308.8	227.8	389.9	379.0	207.5	398.1	396.7
MAX HEATING RATE	$\mathrm{BTU}/\mathrm{ft}^2\mathrm{sec})$		REMTECH	1.38	3.57	1.92	2.87	2.65	5.46	3.43	9.14	7.08	89.6	92.9	3.52	1.06	1.24	6.51	6.96	7.00	96.9	6.72	9.41	9.01
MAX			RI	1.41	3.62	2.00	3.51	3.26	5.21	4.39	9.09	6.97	9.24	6.92	3.02	1.00	1.05	6.49	3.50	8.39	7.99	1.98	9.21	9.34
LOCATION				LH2 Tank Acreage				·																
INATES		$\theta_{T}$	(deg)	180.0	270.0	315.0	337.5	250.5	289.5	250.5	289.5	312.6	355.0	250.0	0.0	180.0	225.0	247.0	270.0	283.9	319.4	337.5	357.1	358.8
COORDINATES		$X_T$	(in)	2036.46	2036.46	2036.46	2036.46	2040.75	2048.45	2048.75	2052.65	2053.50	2053.50	2053.75	2058.00	2058.00	2058.00	2058.00	2058.00	2058.00	2058.00	2058.00	2058.00	2058.00
BODY POINT				7929	7925	7922	7921	1041	1023	1043	1025	1205	1303	1046	7930	7939	7937	1054	7935	1032	1211	7931	1307	1309

2) Integrated heat loads contain both acroheating and plume convection.

Note: 1) Maximum heating rates pertain to the aeroheating only. Consequently in plume dominated areas between  $96 \le t \le 126$  seconds,  $\dot{q}_{max}$  is listed for  $t \le 95$  seconds. For plume convection maximum heating rates see Table 14 of this

TABLE 2 : AEROHEATING AND PLUME CONVECTION MAX HEATING RATE SUMMARY FOR BODY POINT LOCATIONS  $X_T \geq 1872$ 

		<u> </u>	Aerohe	eating*	Plume Conv.	
			REMTECH	RI	RI	Method to use when
Body	$X_T$	$ heta_T$	Max Heating	Max Heating	Max Heating	$96 \sec \leq t \leq 126 \sec$
Point			Rate	Rate	Rate	·
7830	1872.20	0.0	2.42	1.99	3.91	Plume Convection
7839	1872.20	180.0	1.38	1.34	3.65	Plume Convection
7837	1872.20	225.0	1.30	1.38	3.65	Plume Convection
7836	1872.20	247.5	1.32	1.13	3.91	Plume Convection
7835	`1872.20	270.0	1.46	3.15	3.91	Plume Convection
7834	1872.20	292.5	1.94	4.24	3.91	Aeroheating
7832	1872.20	315.0	1.85	1.75	3.91	Plume Convection
7831	1872.20	337.5	1.27	1.55	3.91	Plume Convection
7850	1898.04	0.0	1.70	2.77	3.91	Plume Convection
7859	1898.04	180.0	. 1.23	1.53	3.65	Plume Convection
7855	1898.04	270.0	1.88	1.98	3.65	Plume Convection
7852	1898.04	315.0	1.79	2.40	3.65	Plume Convection
1406	1914.65	304.0	5.47	5.39	3.91	Aeroheating
1409	1914.65	315.0	2.97	3.07	3.91	Plume Convection
51308	1916.00	30.9	2.17	2.08	3.91	Plume Convection
51309	1916.00	30.9	2.36	2.24	3.91	Plume Convection
51311	1916.00	30.9	1.63	1.57	3.91	Plume Convection
1414	1936.79	330.2	3.74	3.51	3.91	Plume Convection
6632	1955.30	23.5	1.96	1.11	3.91	Plume Convection
6633	1962.78	23.5	2.03	1.39	3.91	Plume Convection
6634	1968.39	23.5	2.08	1.75	3.91	Plume Convection
6637	1971.66	23.5	2.11	2.96	3.91	Plume Convection
6638	1976.81	23.5	1.07	0.81	3.91	Plume Convection
6639	1980.31	23.5	1.07	0.93	3.91	Plume Convection
6640	1984.05	23.5	1.07	0.91	3.91	Plume Convection
6909	1999.54	19.0	2.27	2.32		Aeroheating
51608	2028.00	30.9	6.50	6.05	3.91	Plume Convection

TABLE 2 CONC: AEROHEATING AND PLUME CONVECTION MAX HEATING RATE SUMMARY FOR BODY POINT LOCATIONS  $X_T \geq 1872$ 

			Aerohe	eating*	Plume Conv.	
			REMTECH	RI	RI	Method to use when
Body	$\mathbf{X}_{T}$	$ heta_T$	Max Heating	Max Heating	Max Heating	$96 \sec \leq t \leq 126 \sec$
Point	_	_	Rate	Rate	Rate	
51609	2028.00	30.9	7.07	6.38	3.91	Plume Convection
51611	2028.00	30.9	4.80	5.02	3.91	Plume Convection
1021	2031.65	289.5	4.65	5.26	3.91	Plume Convection
1300	2032.00	355.0	7.86	8.42	3.91	Plume Convection
6647	2033.00	23.5	7.47	7.62	3.91	Plume Convection
6929	2036.45	19.0	10.60	11.14	3.91	Plume Convection
7920	2036.46	0.0	5.49	5.88	3.91	Plume Convection
7929	2036.46	180.0	1.38	1.41	3.65	Plume Convection
7925	2036.46	270.0	3.57	3.62	3.91	Plume Convection
7922	2036.46	315.0	1.92	2.00	3.91	Plume Convection
7921	2036.46	337.5	2.87	3.51	3.91	Plume Convection
1041	2040.76	250.5	2.65	3.26	3.91	Plume Convection
1023	2048.45	289.5	5.46	5.21	3.91	Plume Convection
1043	2048.75	250.5	3.43	4.39	3.91	Plume Convection
1025	2052.65	289.5	9.14	9.09	3.91	Plume Convection
1205	2053.50	312.6	7.08	6.97	3.91	Plume Convection
1303	2053.50	355.0	9.68	9.24	3.91	Plume Convection
1046	2053.75	250.5	6.76	6.92	3.91	Plume Convection
7930	2058.00	0.0	3.52	3.02	3.91	Plume Convection
7939	2058.00	180.0	1.06	1.00	3.65	Plume Convection
7937	2058.00	225.0	1.24	1.05	3.65	Plume Convection
1054	2058.00	247.0	6.51	6.49	3.91	Plume Convection
7935	2058.00	270.0	6.96	3.50	3.91	Plume Convection
1032	2058.00	283.9	7.00	8.39	3.91	Plume Convection
1211	2058.00	319.4	6.96	7.99	3.91	Plume Convection
7931	2058.00	337.5	6.72	1.98	3.91	Plume Convection
1307	2058.00	357.1	9.41	9.21	3.91	Plume Convection
1309	2058.00	358.8	9.01	9.34	3.91	Plume Convection

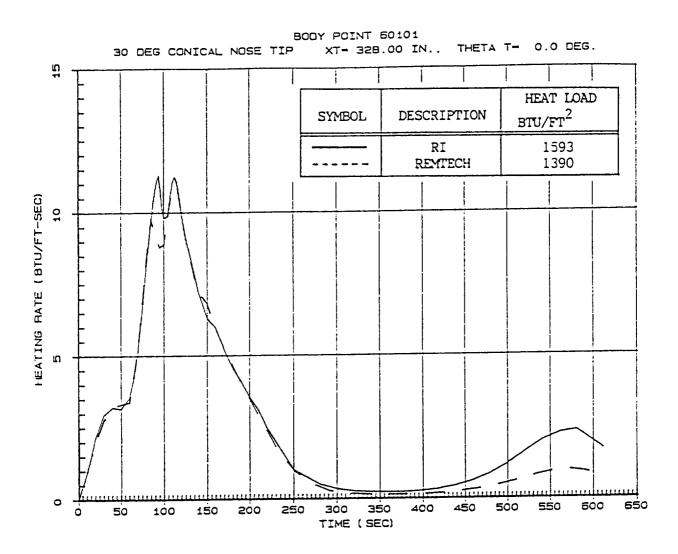
<sup>\*</sup> Note: The aeroheating max. heating rates are for time  $\leq$  95 seconds.

**PLOTTED DATA** TIMEWISE COMPARISON OF REMTECH/ROCKWELL IVBC-3 ASCENT DESIGN HEATING RATES (TW =  $460^{\circ}$ R)

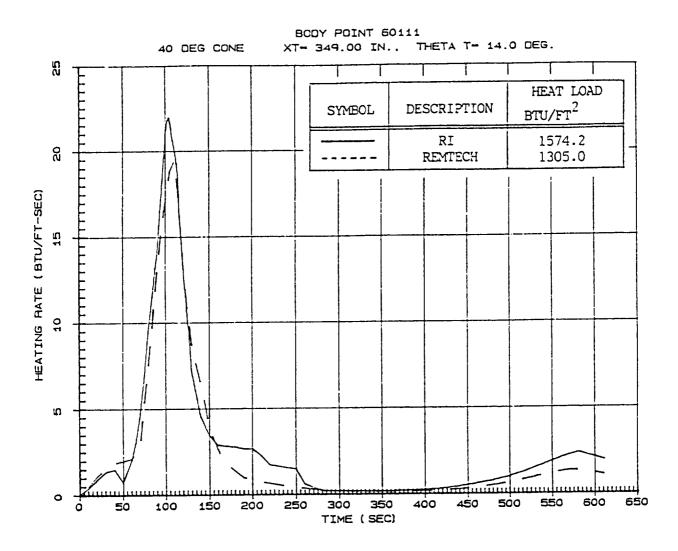
Note: The tabulated heat loads include plume convection for body point locations at  $X_T \ge 1871$ .

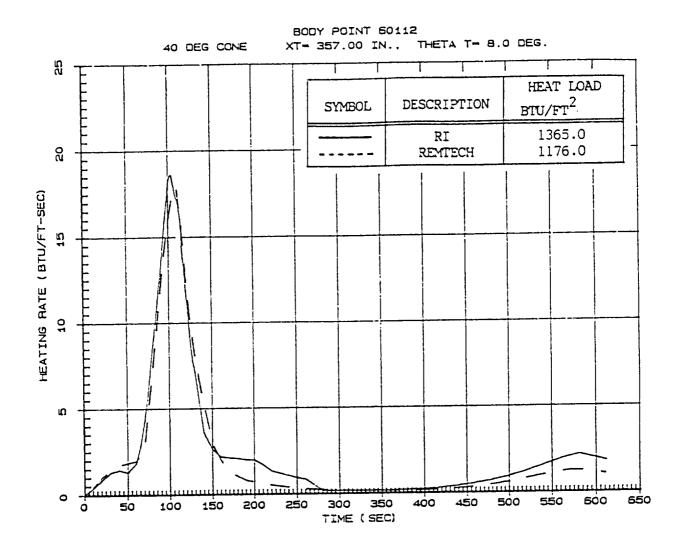
## REMTECH

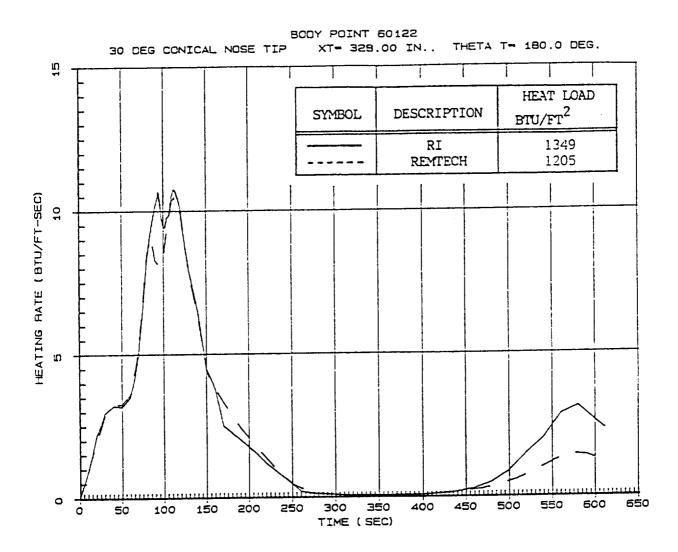
ASCENT DESIGN ENVIRONMENTS FOR THE ET NOSE SPIKE AND 40 DEG CONE ACREAGE BODY POINTS

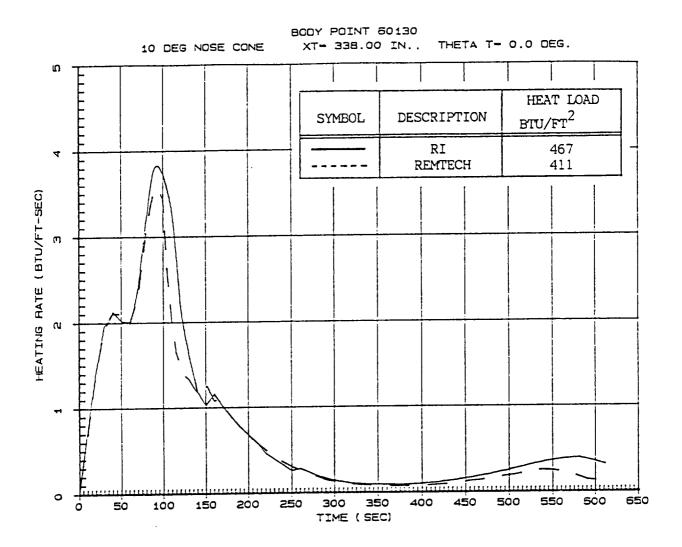


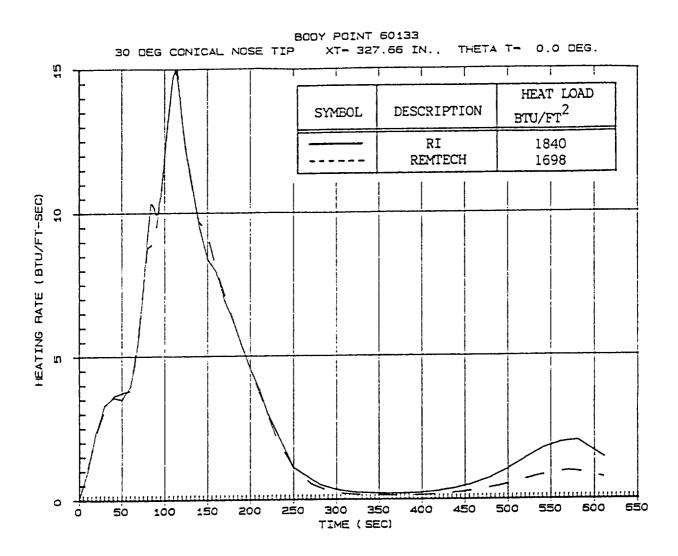
Agreement is acceptable; no TPS impact.



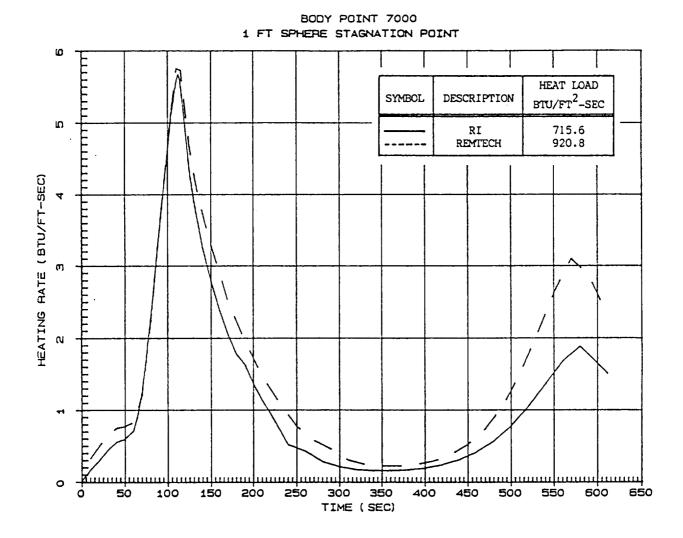






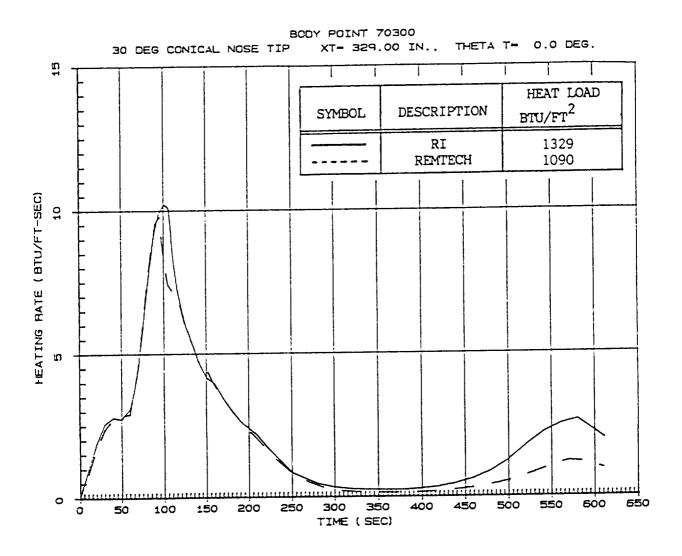


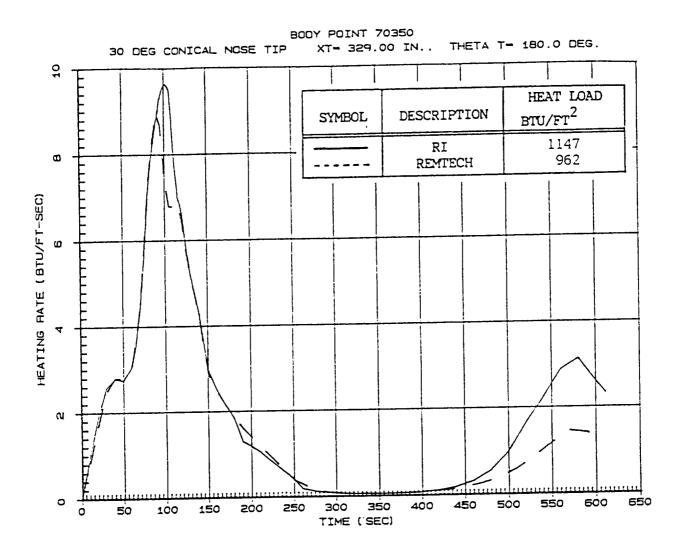
Agreement is acceptable; no TPS impact.

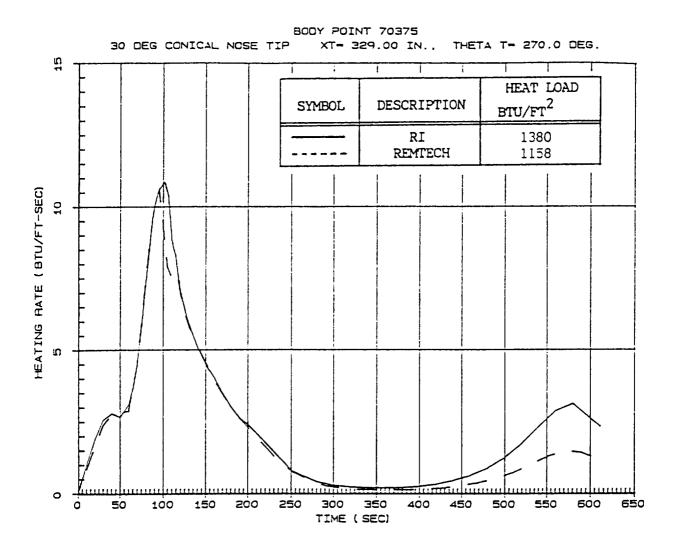


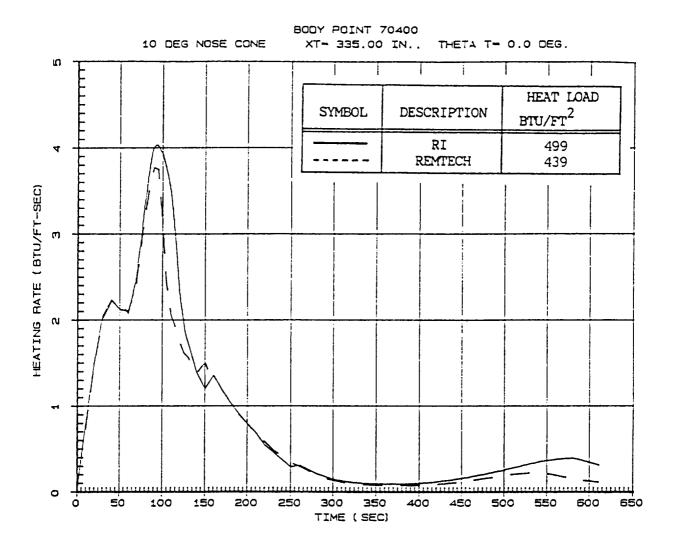
#### COMMENTS

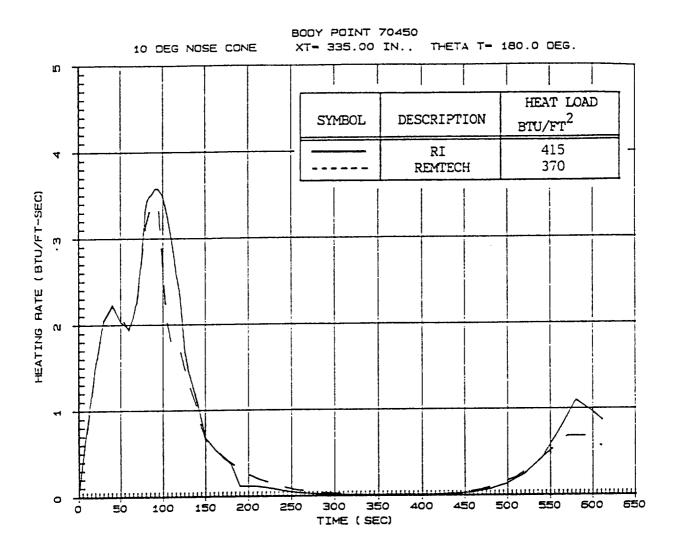
- Acceptable agreement between RI and REMTECH heating rates during first stage flight
- Difference between RI and REMTECH during second stage flight is unacceptable
- Problem analyzed and conclusion was that RI values are incorrectly low during second stage flight

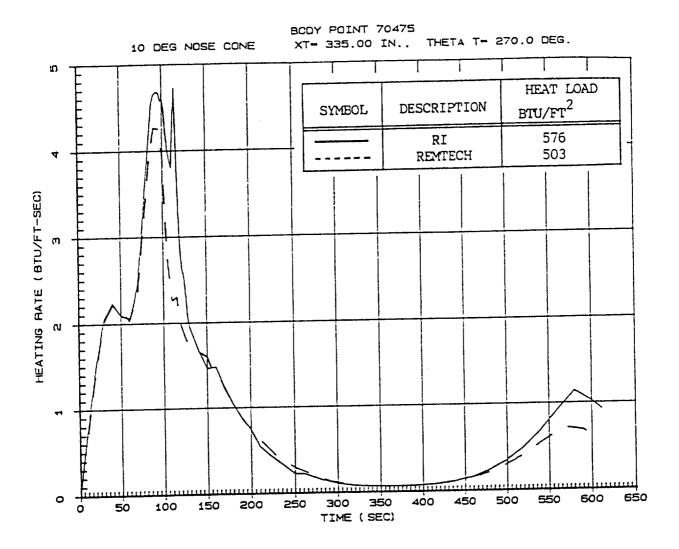


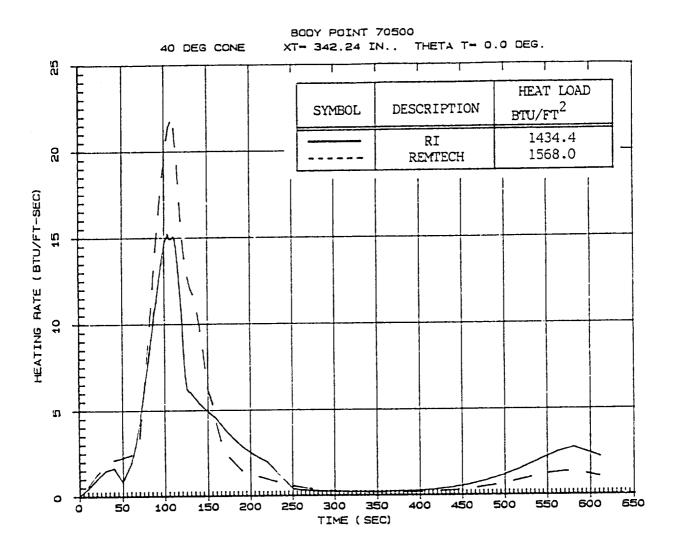




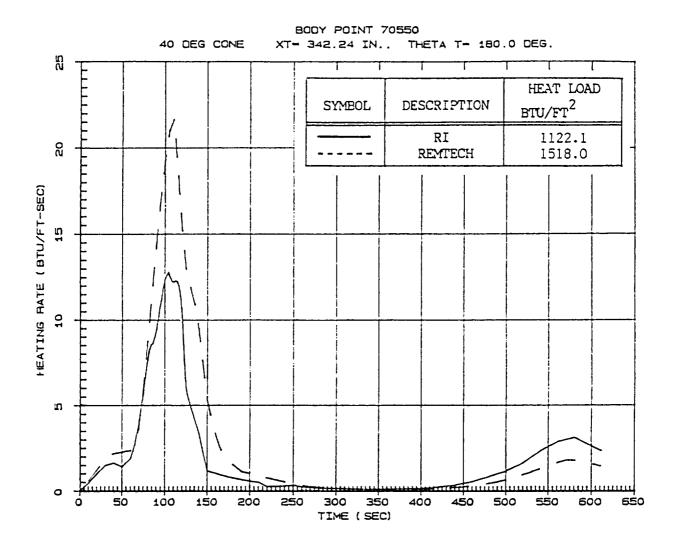




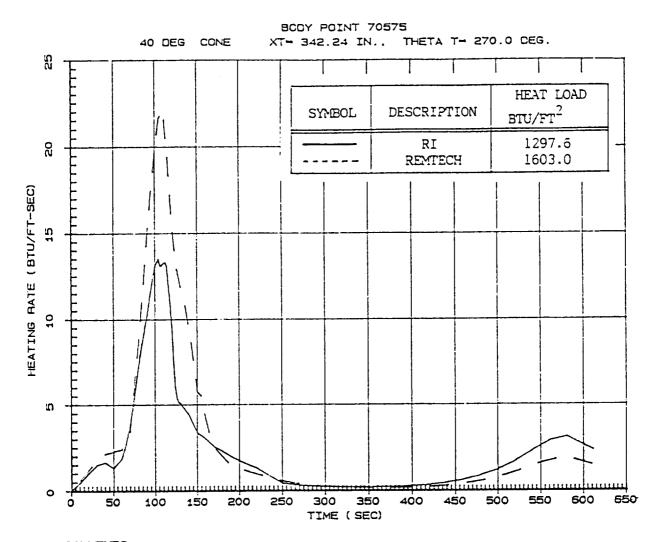




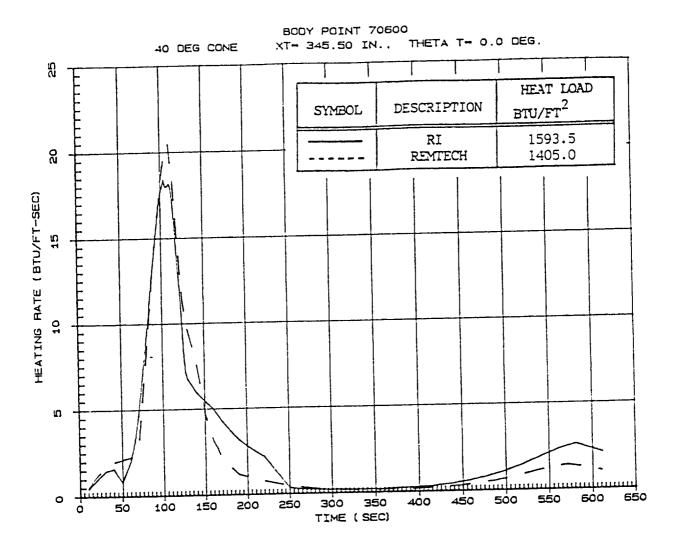
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T$  = 350,  $\theta_T$  = 180)
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $X_{\rm m} < 350$
- Difference between RI and REMTECH environments should not impact current TPS design



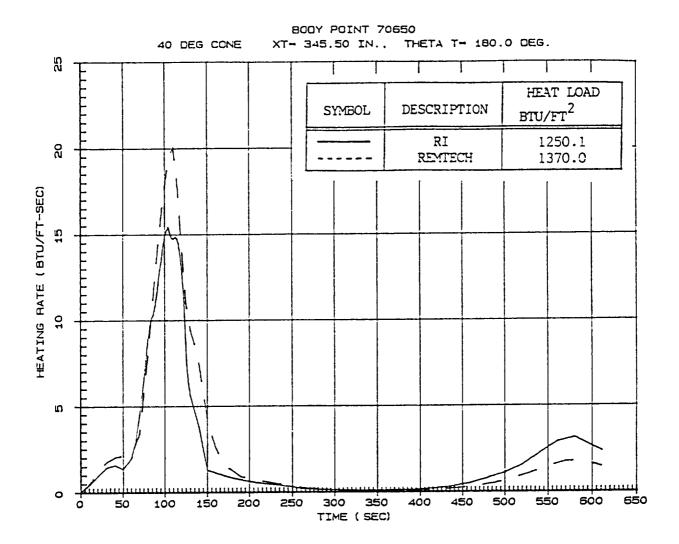
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- $\bullet$  REMTECH environments assumed that the heating amplification factor over the entire  $40^{\circ}$  cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $\rm X_T \le 350$
- Difference between RI and REMTECH environments should not impact current TPS design



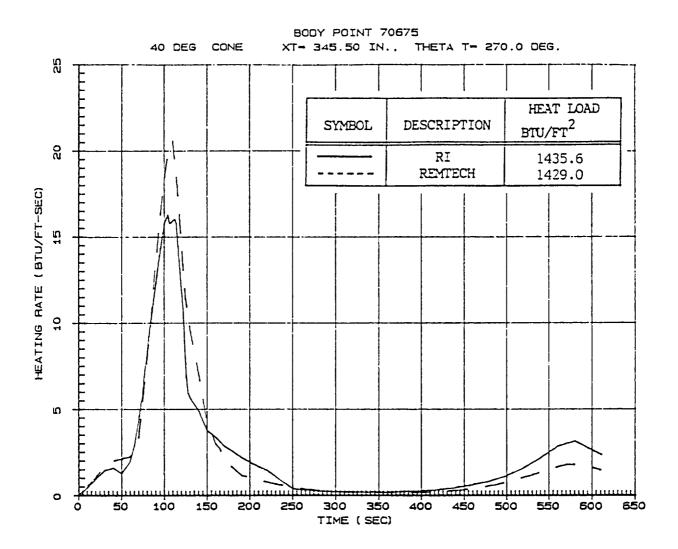
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- $\bullet$  REMTECH environments assumed that the heating amplification factor over the entire  $40^{\circ}$  cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $\rm X_{\overline{L}} < 350$
- Difference between RI and REMTECH environments should not impact current TPS design



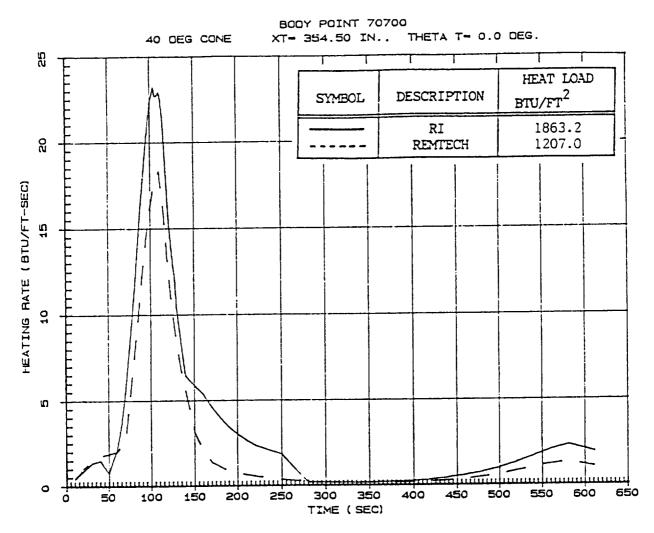
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180^\circ$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $\rm X_T \le 350$
- Difference between RI and REMTECH environments should not impact current TPS design



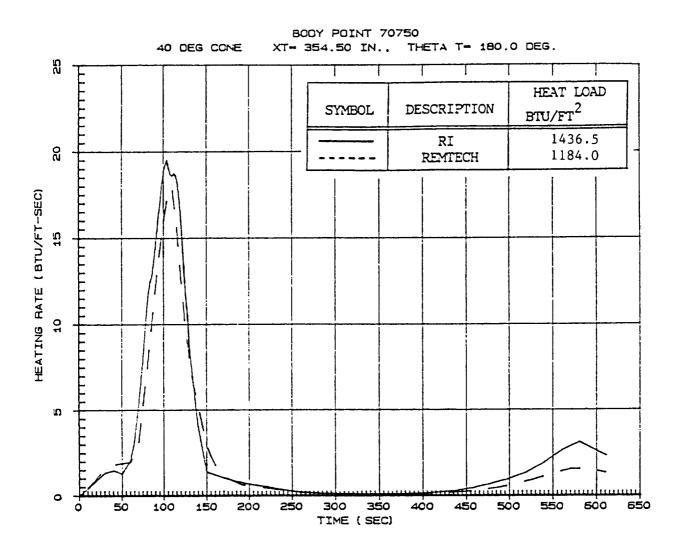
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- $\bullet$  REMTECH environments assumed that the heating amplification factor over the entire  $40^{\circ}$  cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $\rm X_{\overline{L}} < 350$
- Difference between RI and REMTECH environments should not impact current TPS design

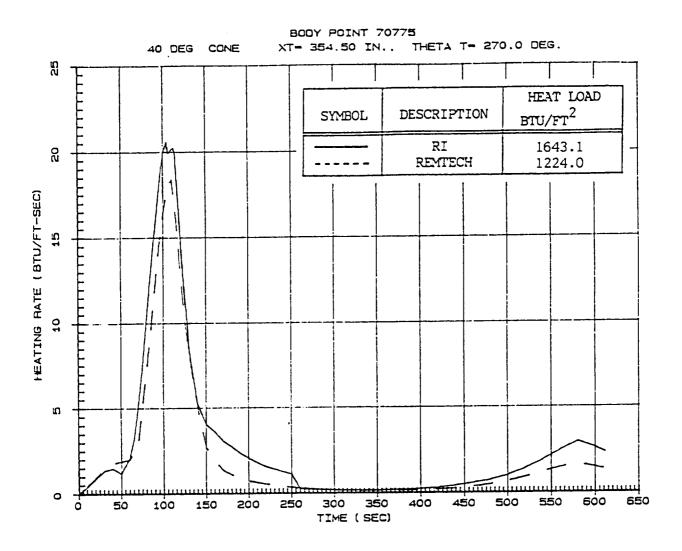


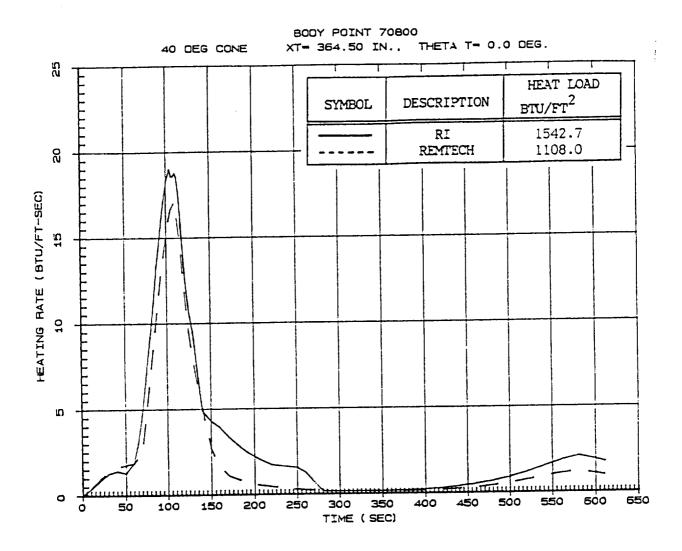
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180^\circ$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone surface is constant
- $\bullet$  RI environments based on wind tunnel distributions which measured low heating levels for  $X_{\rm p} < 350$
- Difference between RI and REMTECH environments should not impact current TPS design

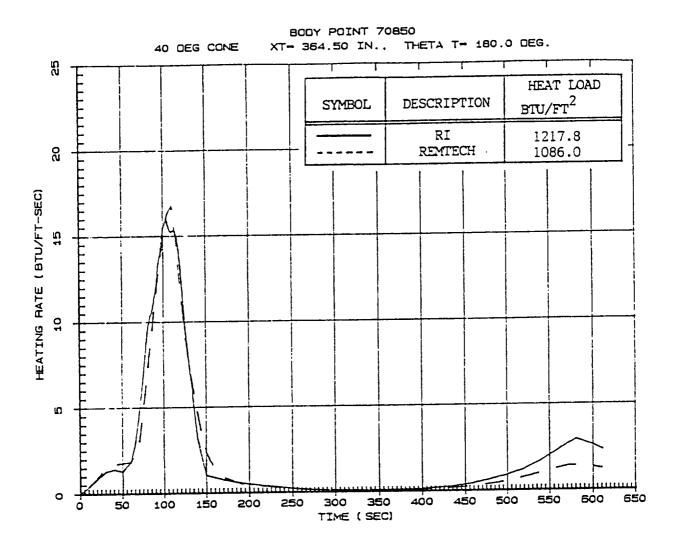


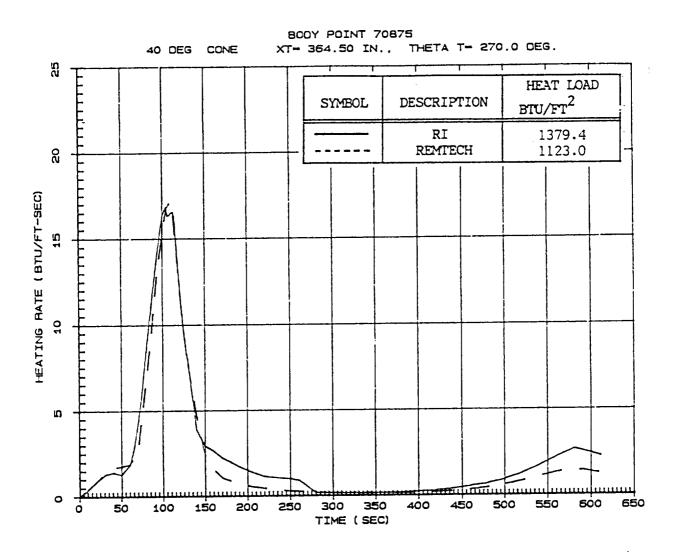
- REMTECH environment includes nose spike interference effects that were based on six sets of flight data measured at one location ( $X_T = 350$ ,  $\theta_T = 180^\circ$ )
- Wind tunnel data was laminar/transitional whereas flight data appeared to be transitional/turbulent
- REMTECH environments assumed that the heating amplification factor over the entire 40° cone is constant
- During first stage flight RI has higher amplification factors than REMIECH
- During first stage flight RI has lower undisturbed heating than REMTECH
- Differences between RI and REMTECH environments should not impact current TPS design











ASCENT DESIGN ENVIRONMENTS FOR THE ET LO<sub>2</sub> TANK ACREAGE BODY POINTS

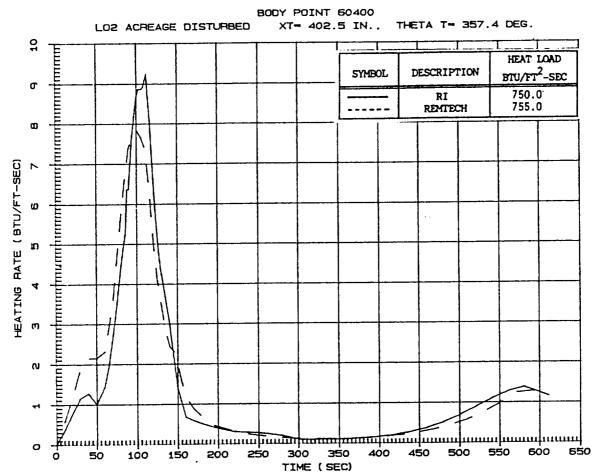
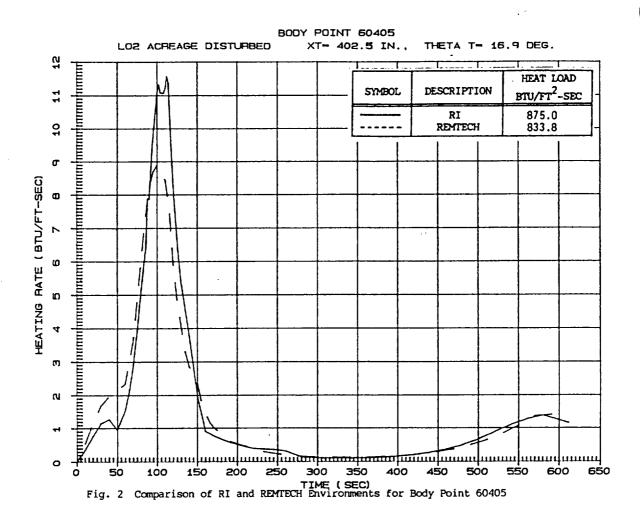


Fig. 1 Comparison of RI and REMTECH Environments for Body Point 60400



ullet The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of  $\sim$  0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

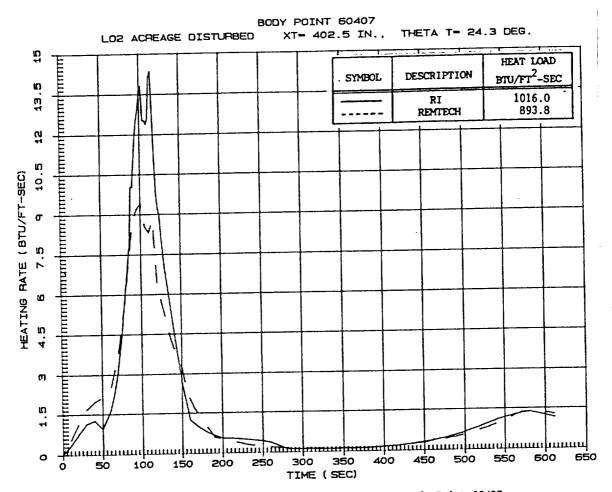


Fig. 3 Comparison on RI and REMTECH Environments for Body Point 60407

• The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of  $\sim$  0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

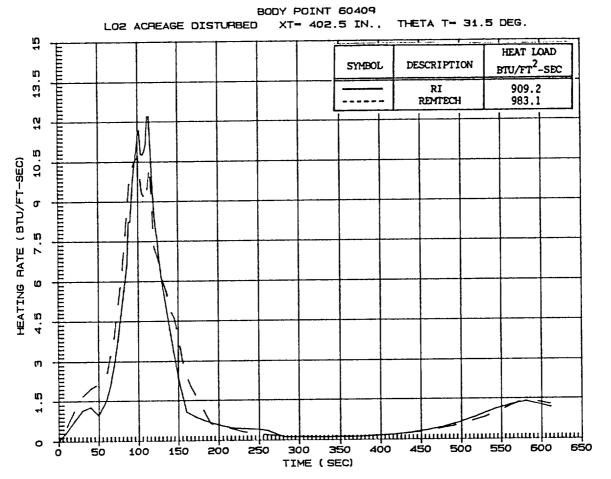


Fig. 4 Comparison of RI and REMTECH Environments for Body Point 60409

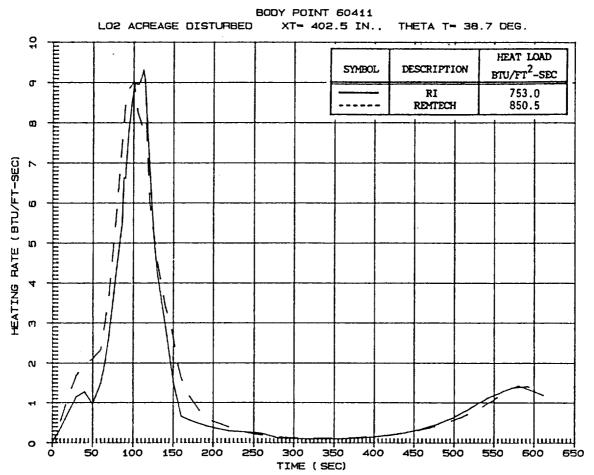


Fig. 5 Comparison of RI and REMTECH for Body Point 60411

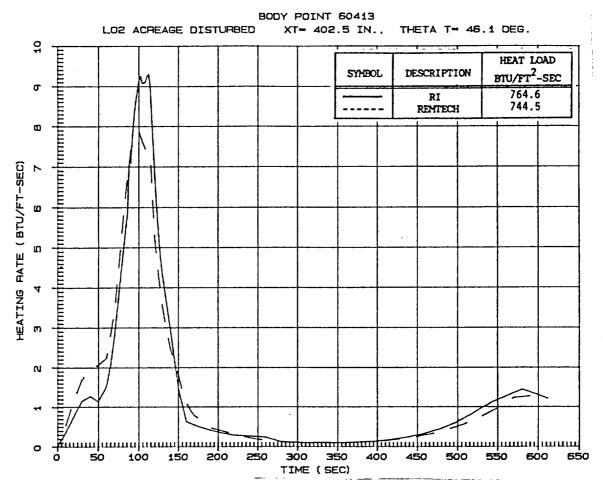


Fig. 6 Comparison of RI and REMITECH Environments for Body Point 60413

• The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of  $\lt$  0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

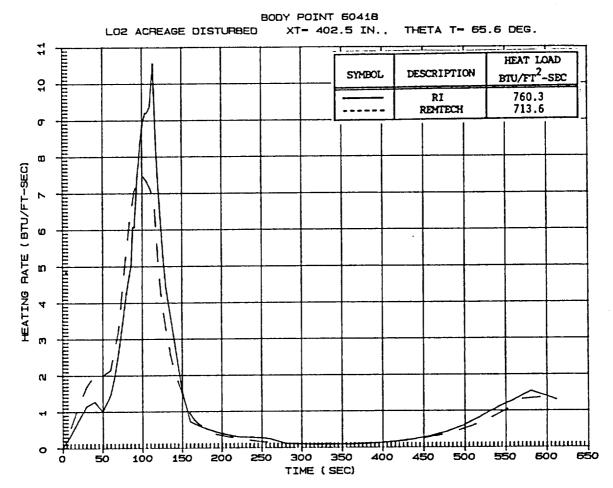


Fig. 7 Comparison of RI and REMTECH Environments for Body Point 60418

• The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of  $\sim$  0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

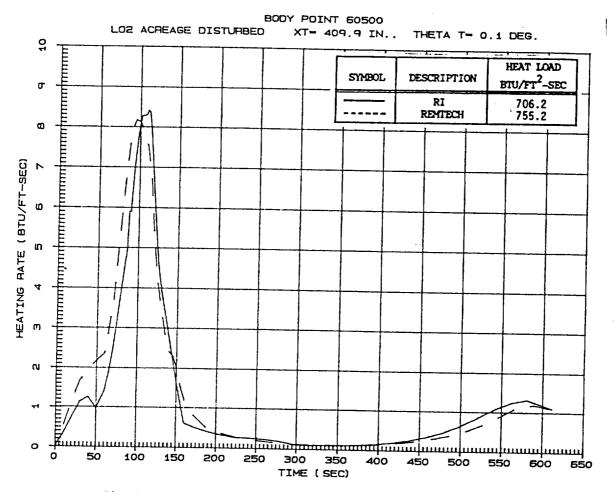


Fig. 8 Comparison of RI and REMTECH Environments for Body Point 60500

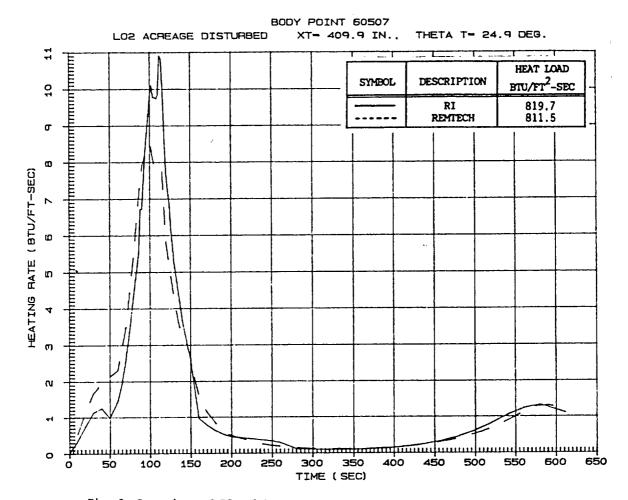


Fig. 9 Comparison of RI and REMTECH environments for Body Point 60507

• The difference in max heating rate between Rockwell and REMTECH generates ~ 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

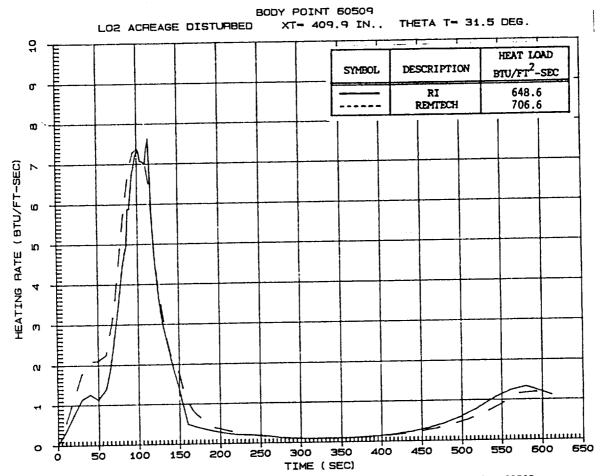


Fig. 10 Comparison of RI and REMTECH Environments for Body Point 60509

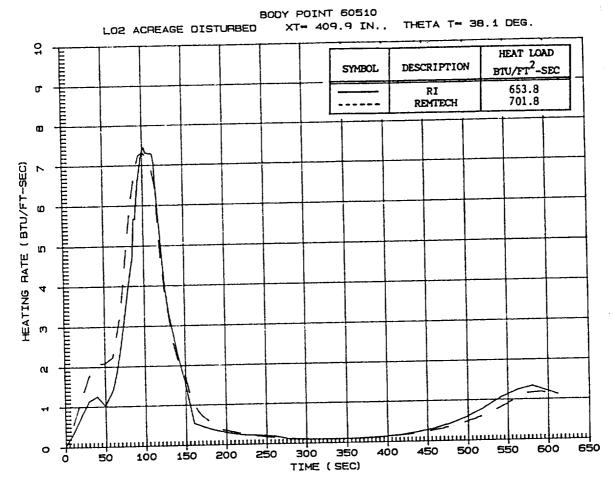


Fig. 11 Comparison of RI and REMTECH Environments for Body Point 60510

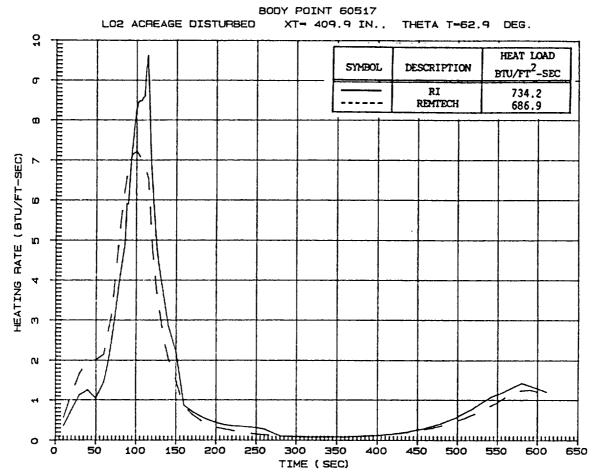


Fig. 12 Comparison of RI and REMTECH Environments for Body Point 60517

• The difference in max heating rate between Rockwell and REMTECH generates < 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

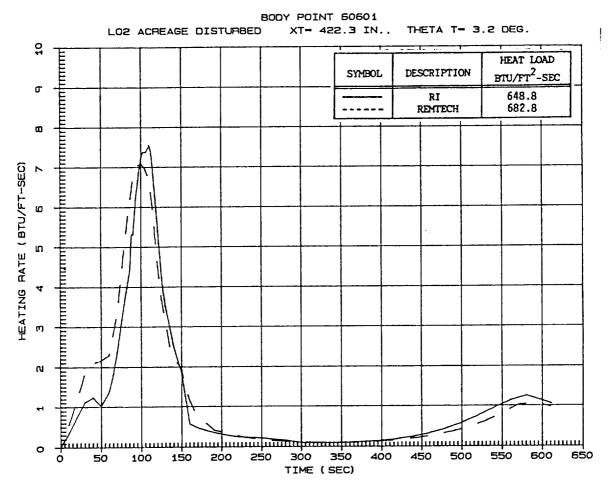


Fig. 13 Comparison of RI and REMITECH Environments for Body Point 60601

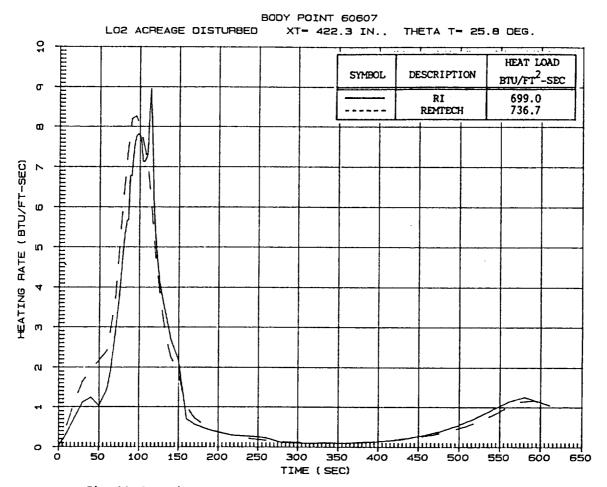


Fig. 14 Comparison of RI and REMITECH Environments for Body Point 60607

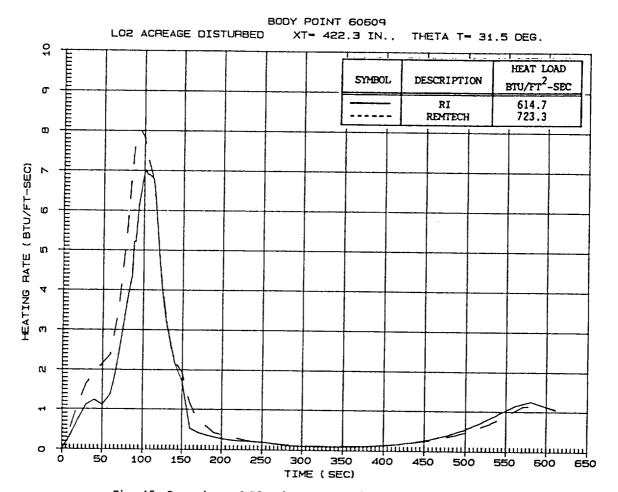


Fig. 15 Comparison of RI and REMTECH Environments for Body Point 60609

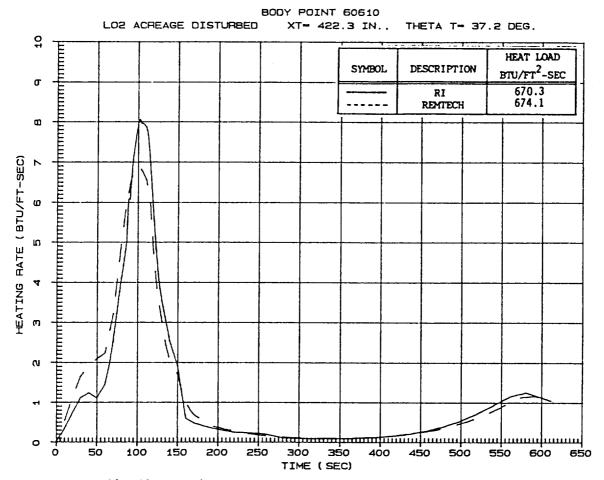
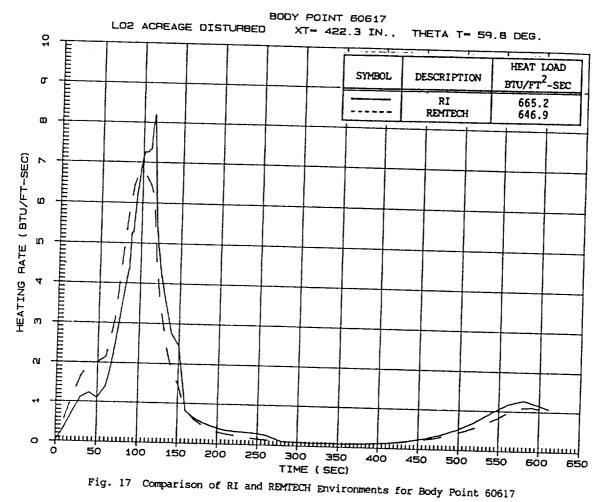
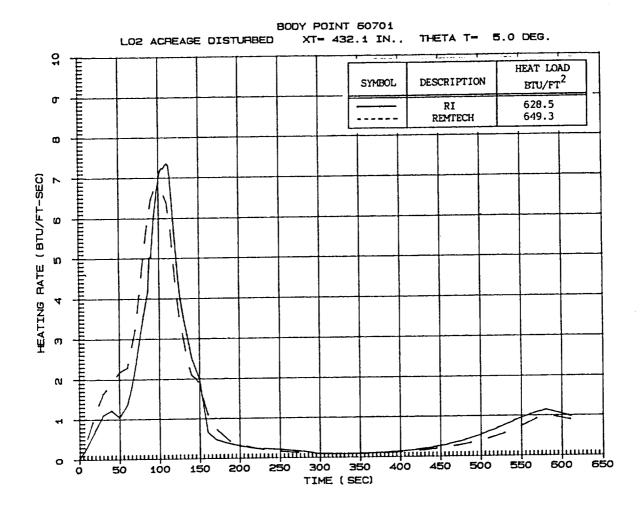
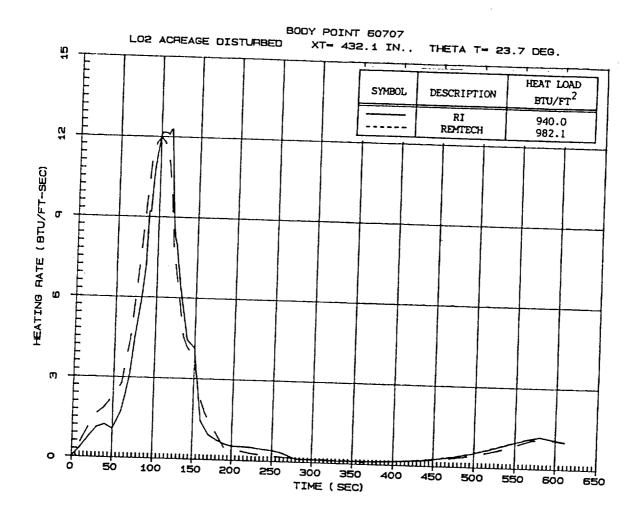
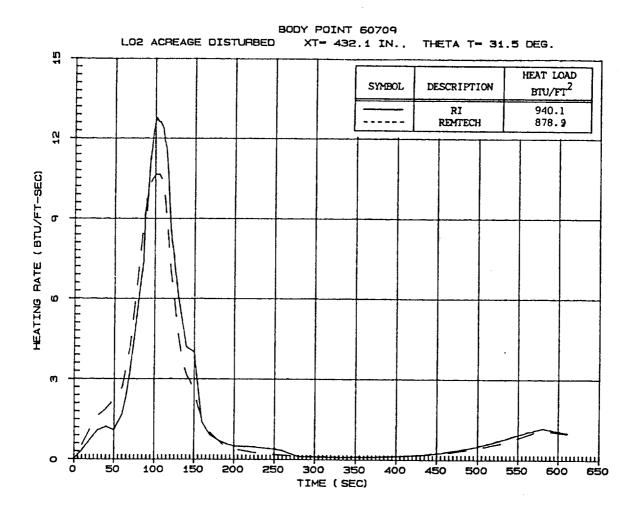


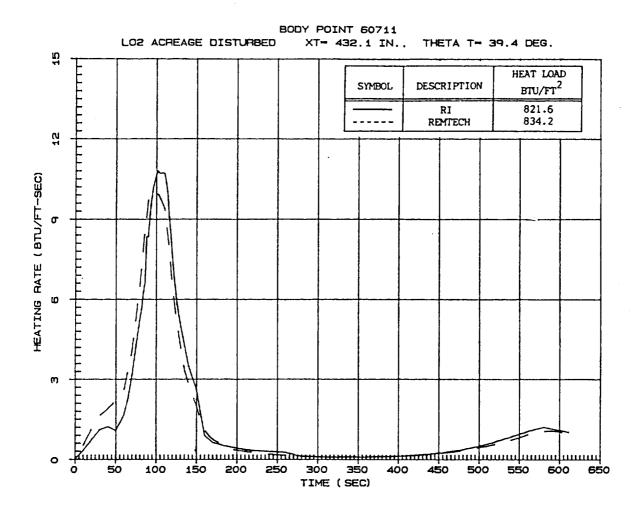
Fig. 16 Comparison of RI and REMTECH Environments for Body Point 60610

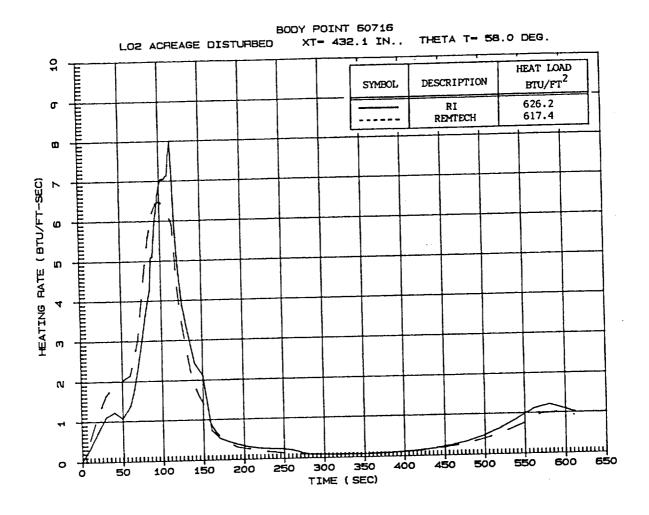


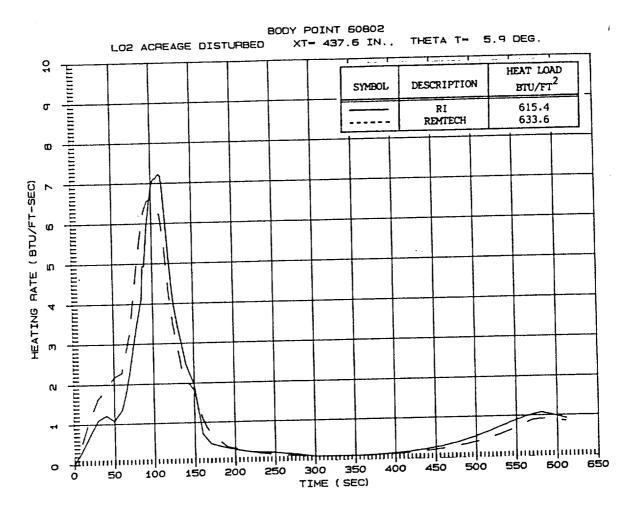


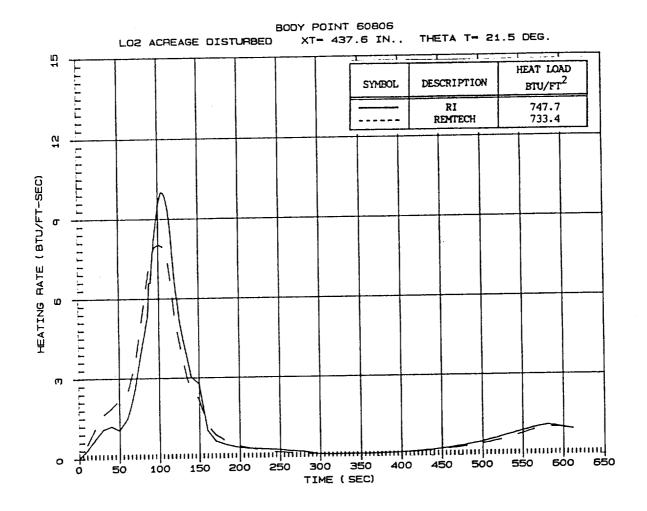


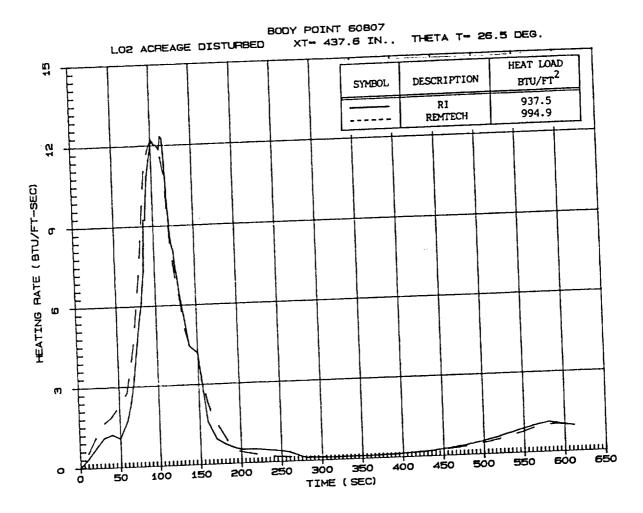


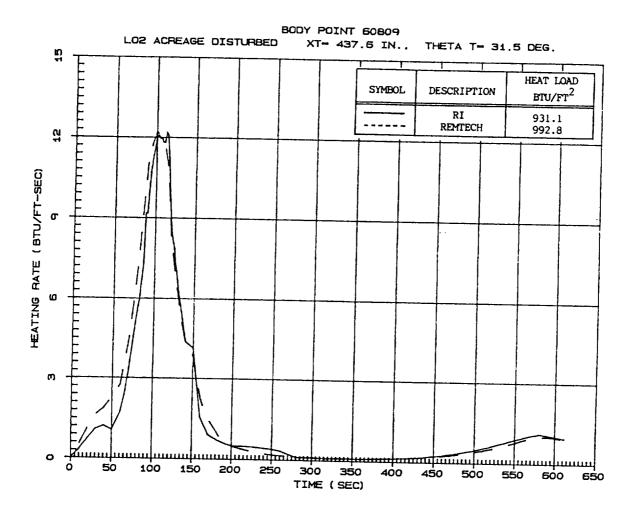


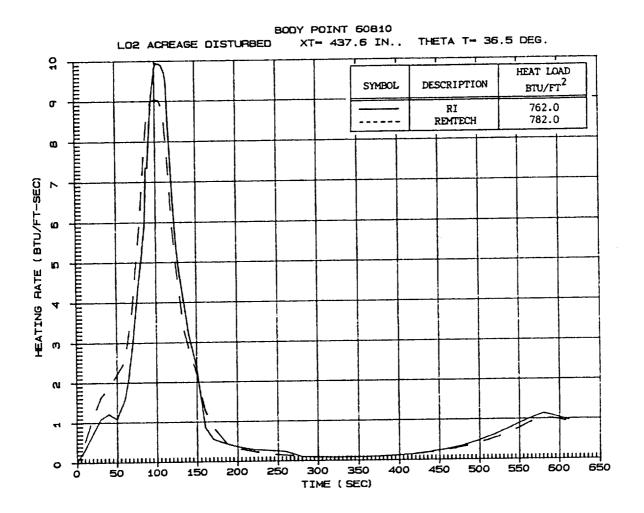


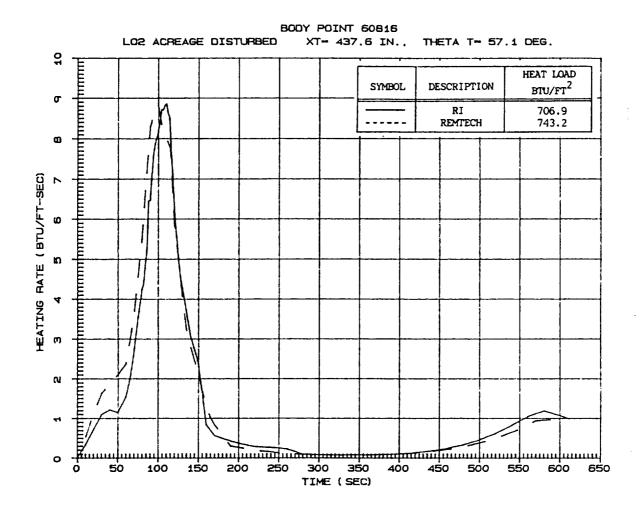


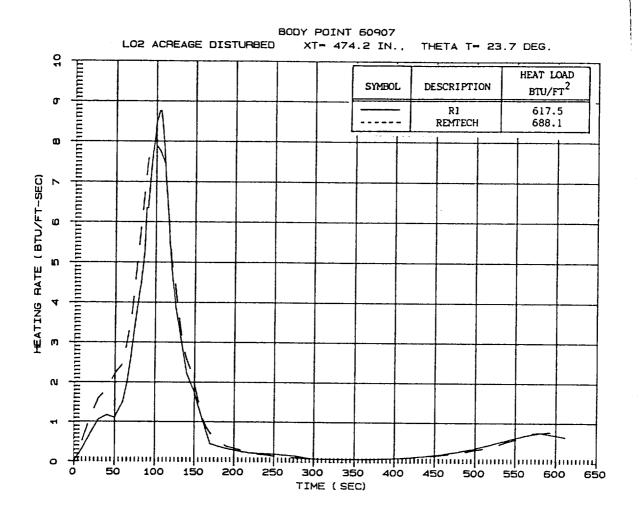


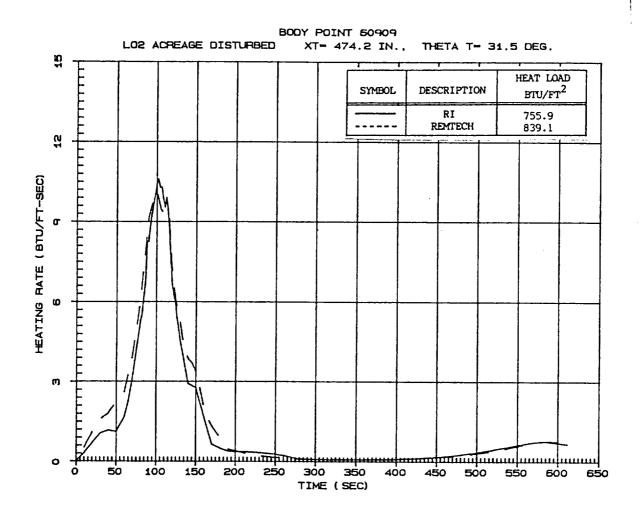




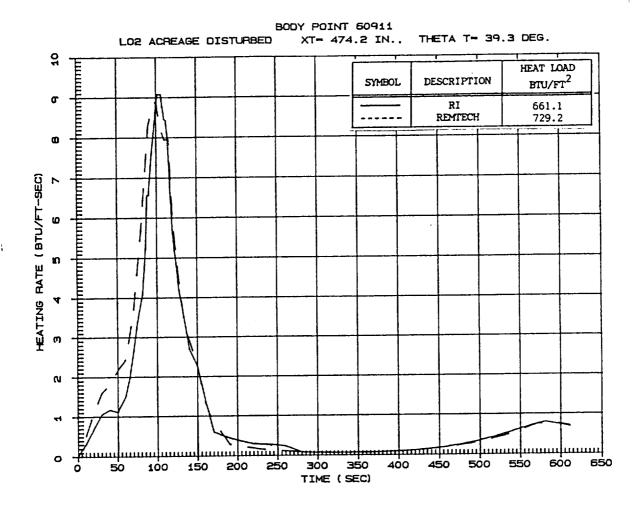


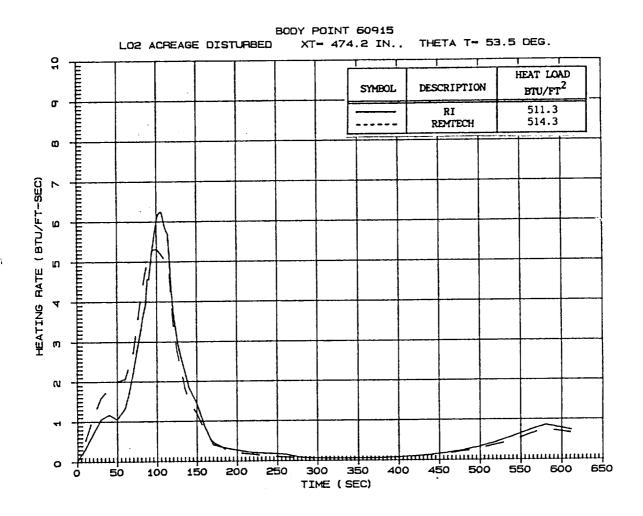


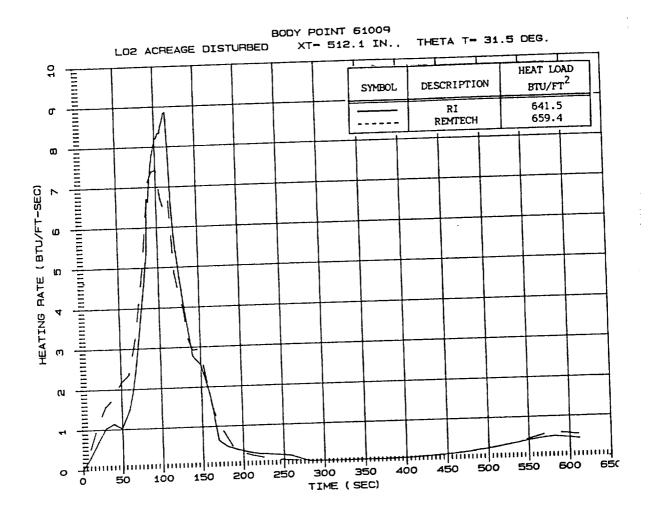


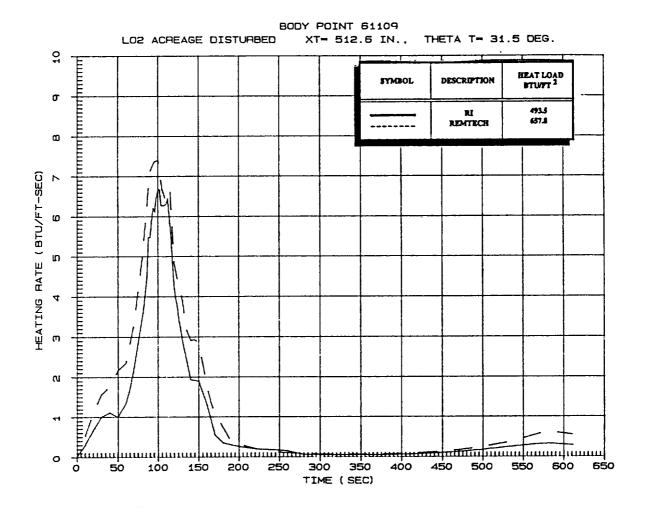


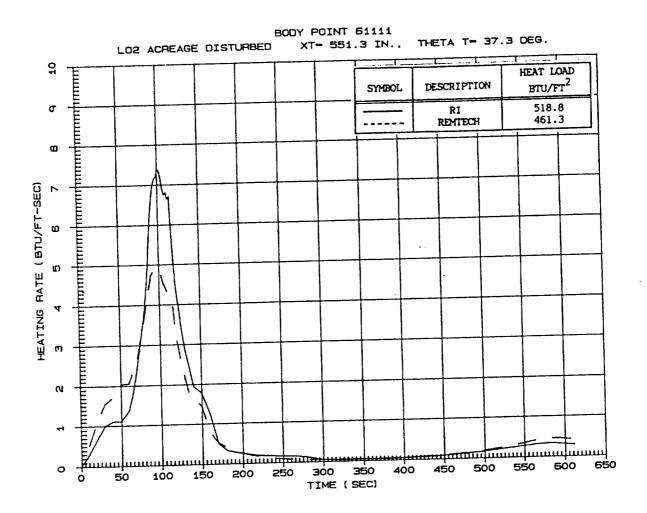
Agreement is acceptable; no TPS impact.



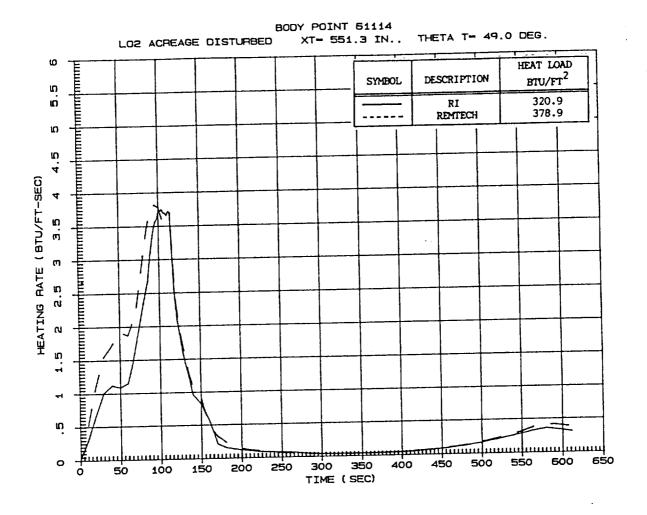


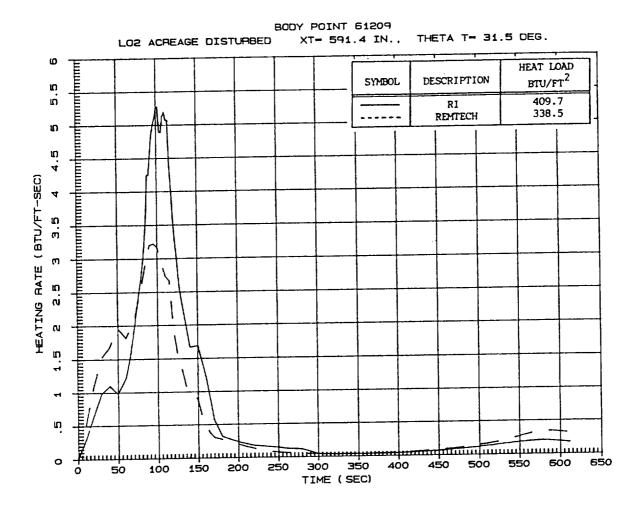




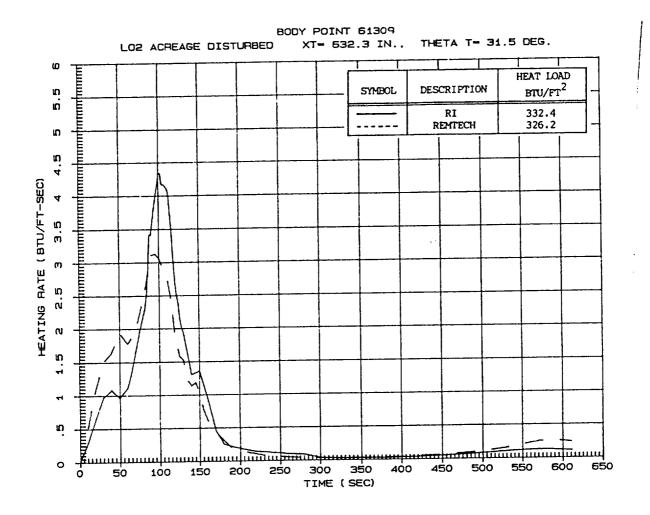


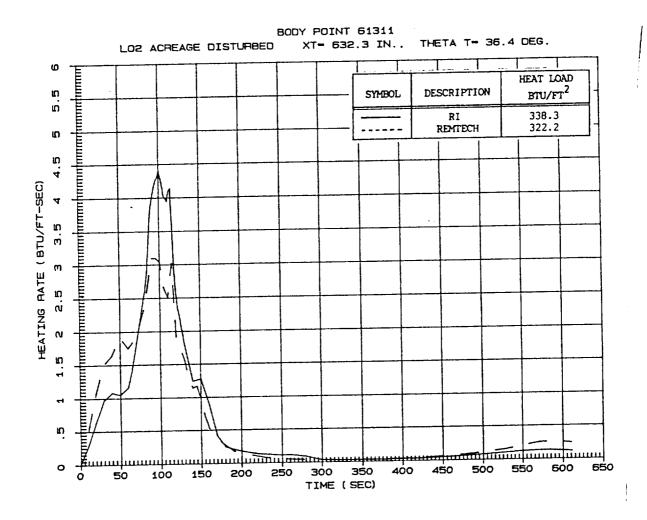
• The difference in max heating rate between Rockwell and REMTECH generates < 0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.



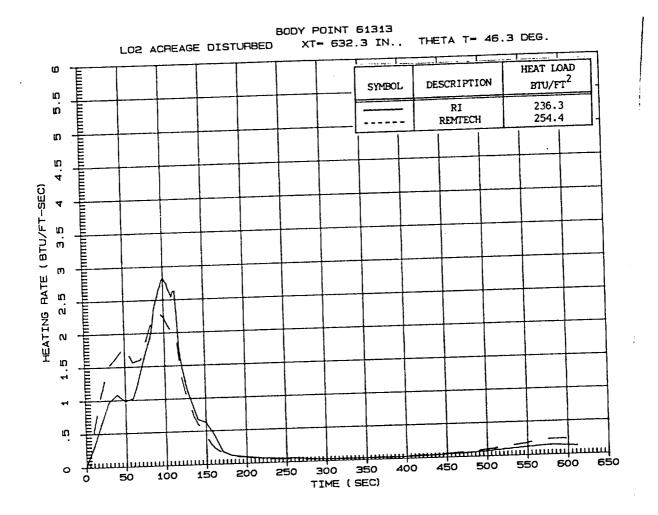


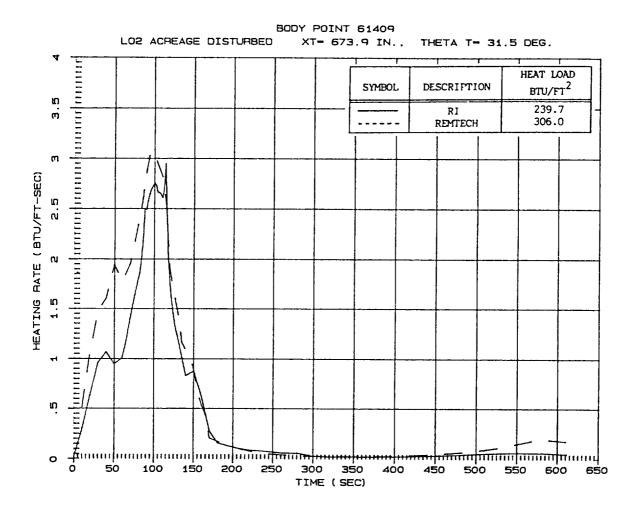
• The difference in maximum heating rate between Rockwell and REMTECH generates into a difference of  $\sim$  0.3 inches of CPR. This is within the uncertainty allowed in applying the TPS.

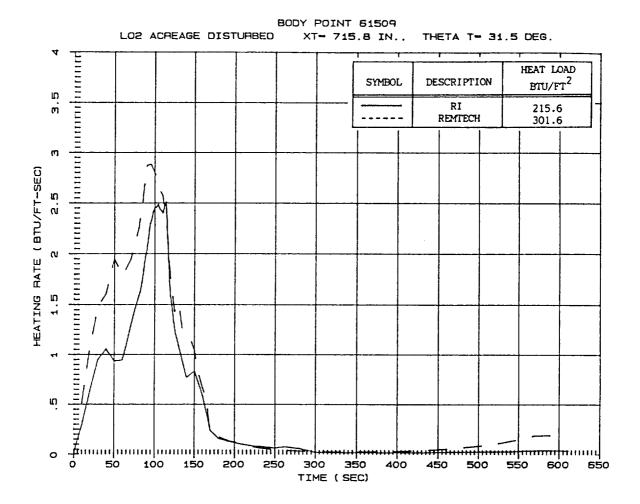


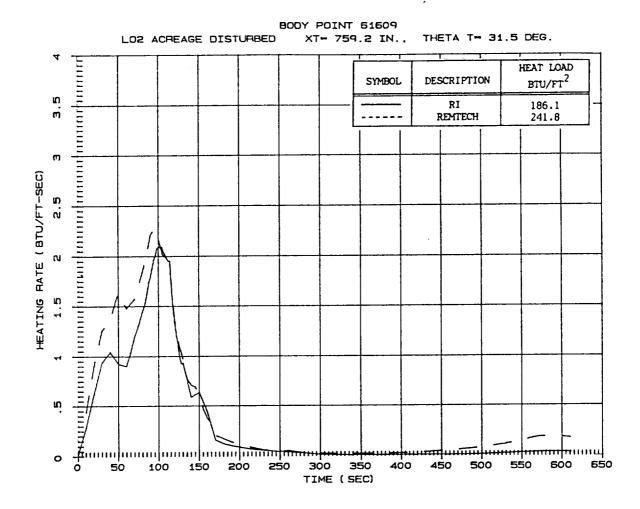


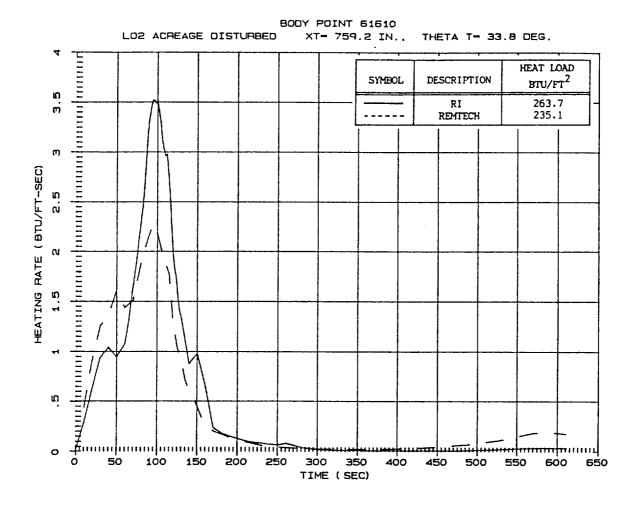
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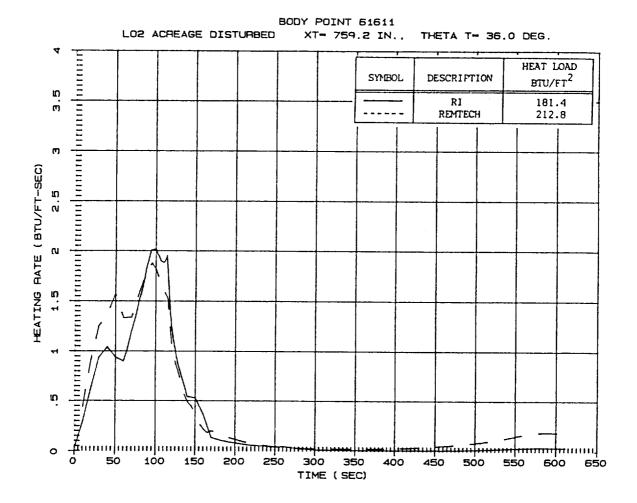


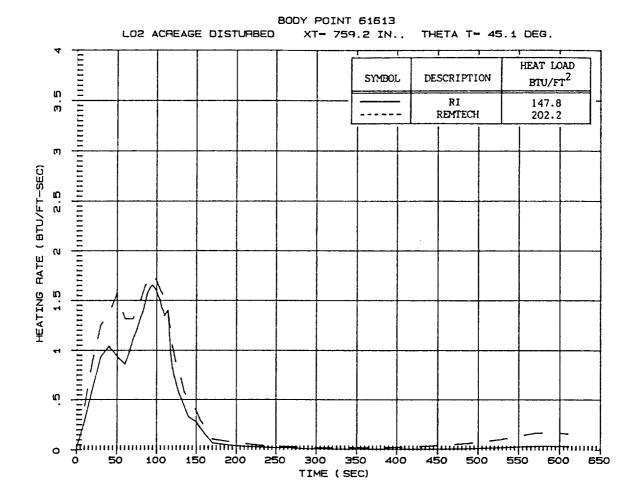


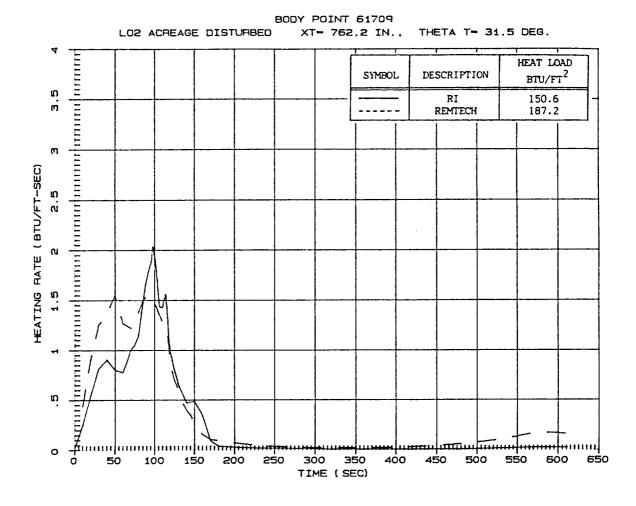


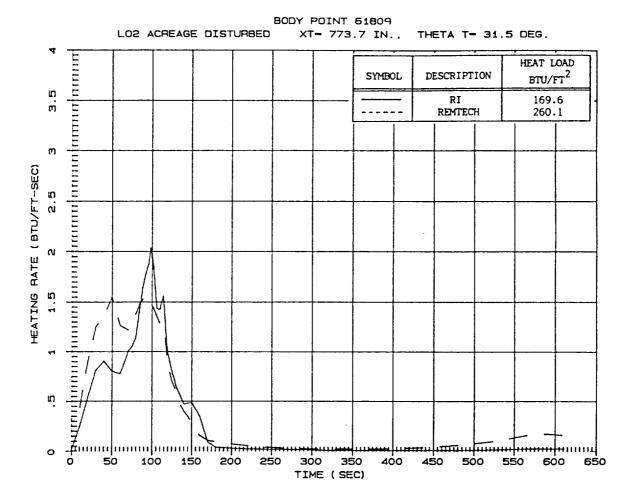


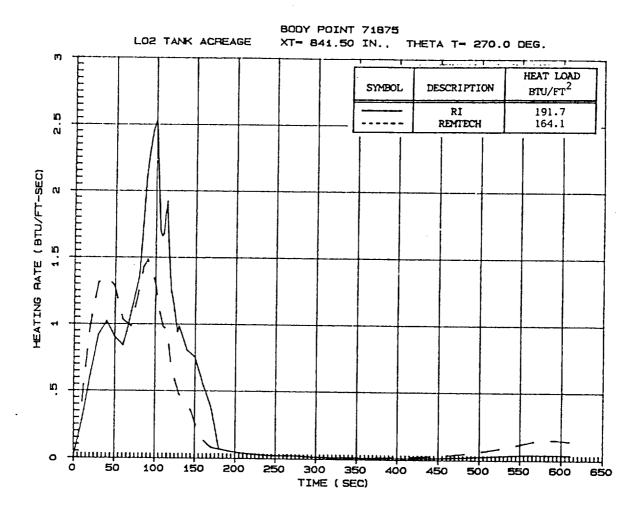


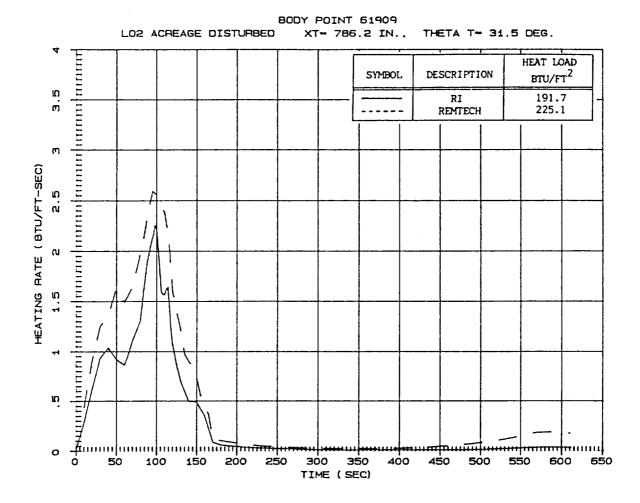


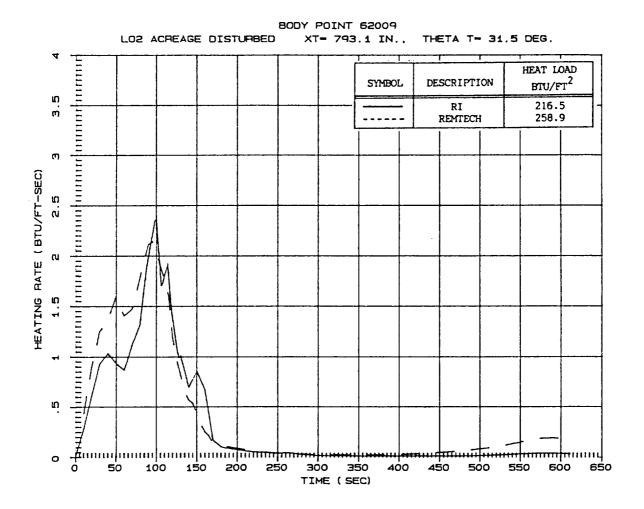


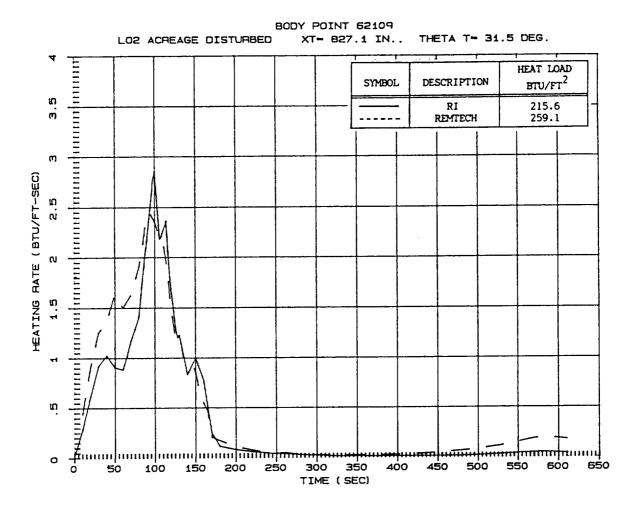


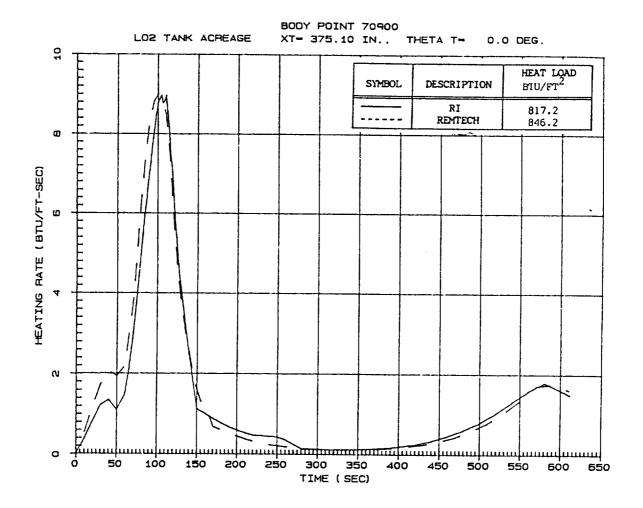


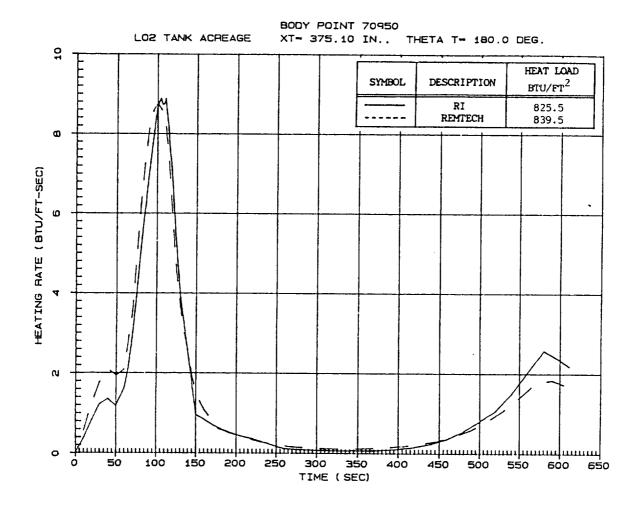


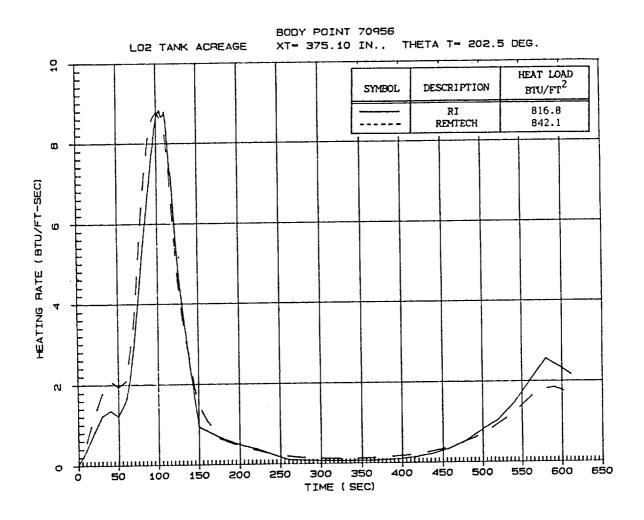


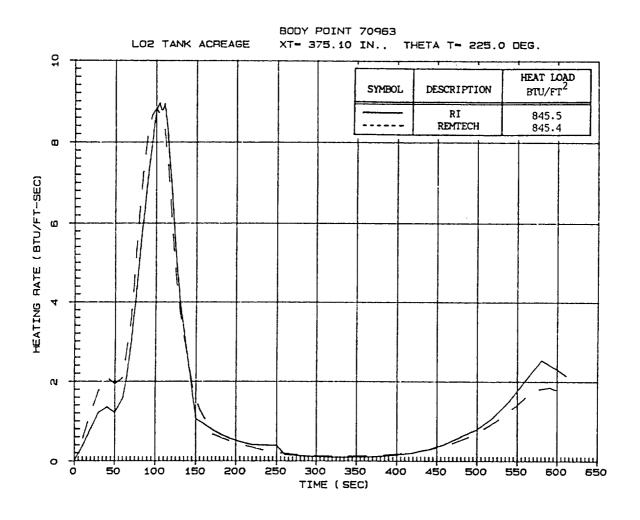


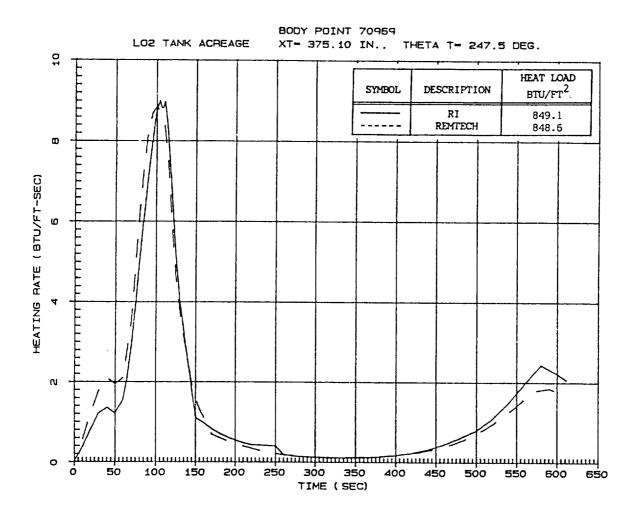


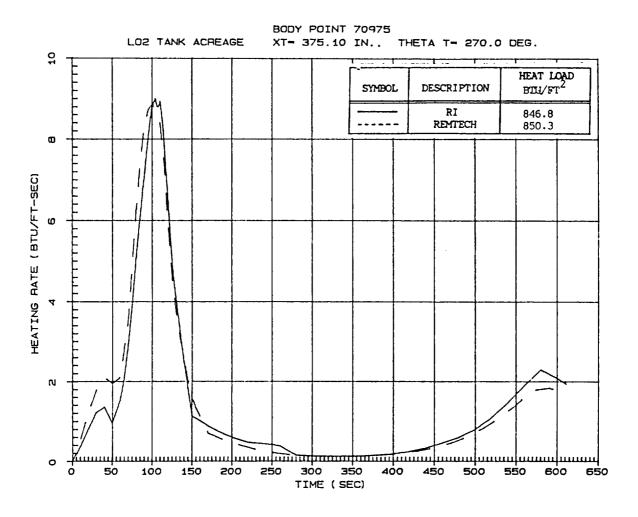


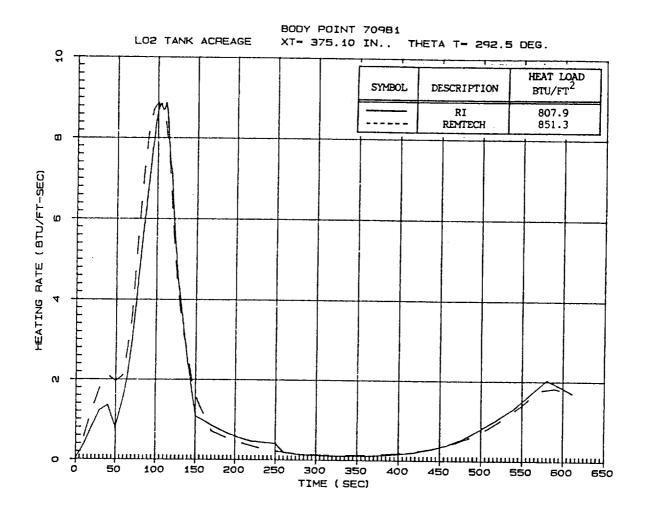


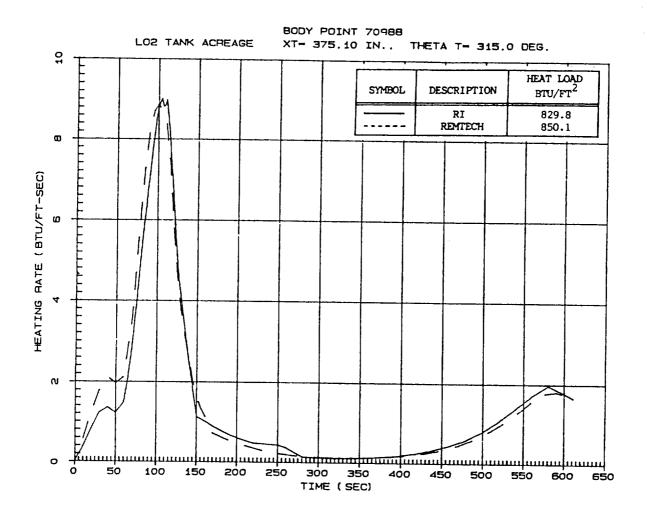


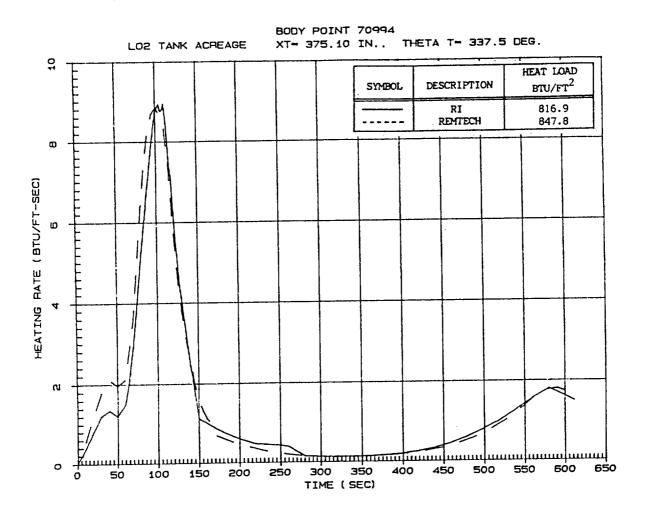


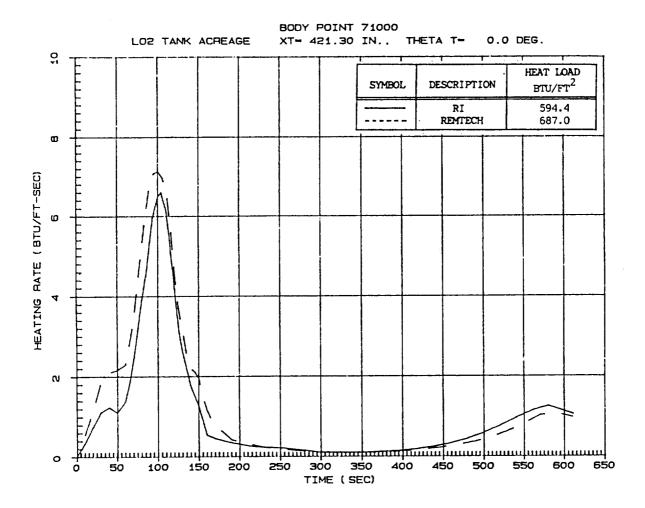


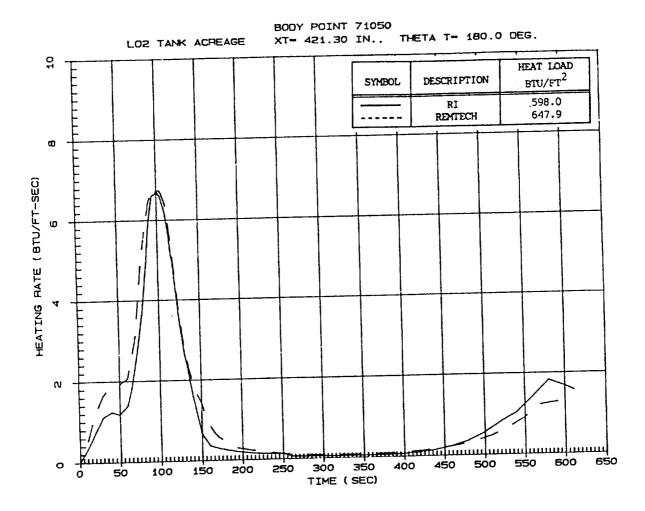


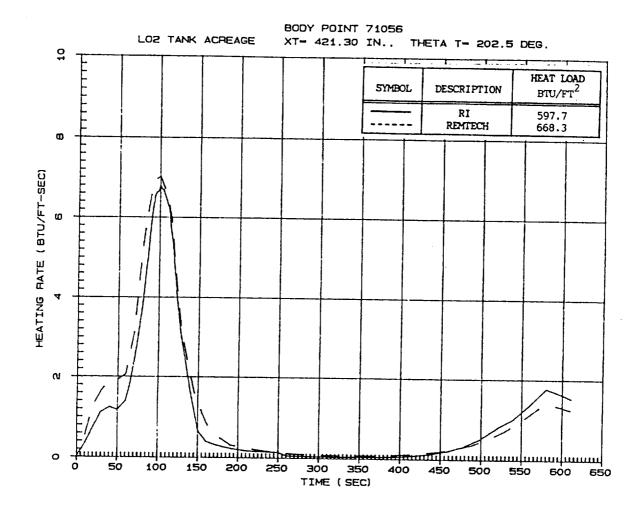


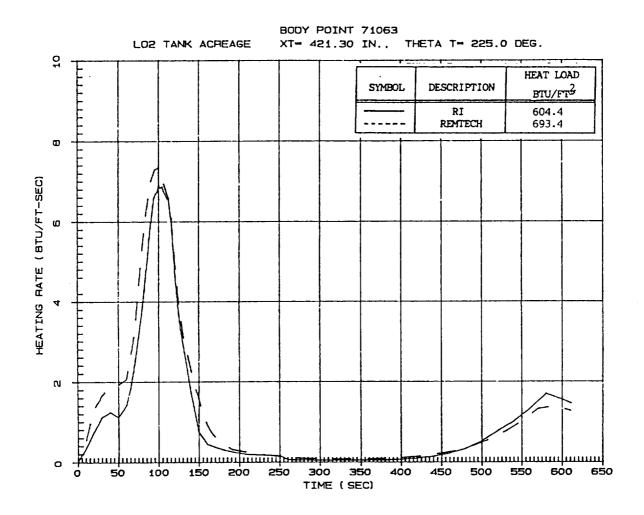


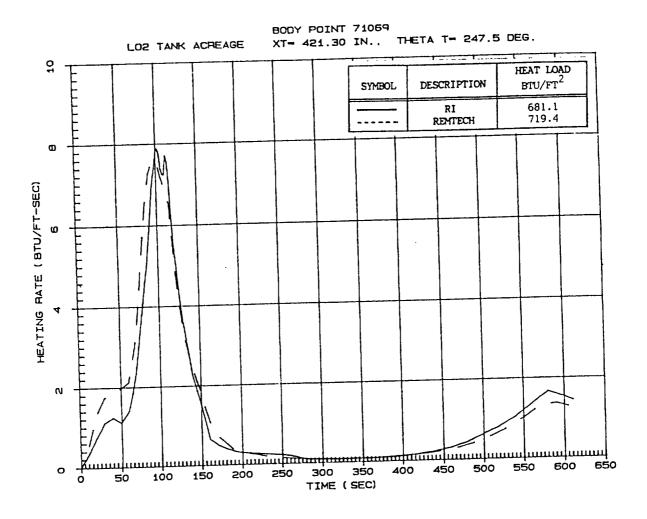


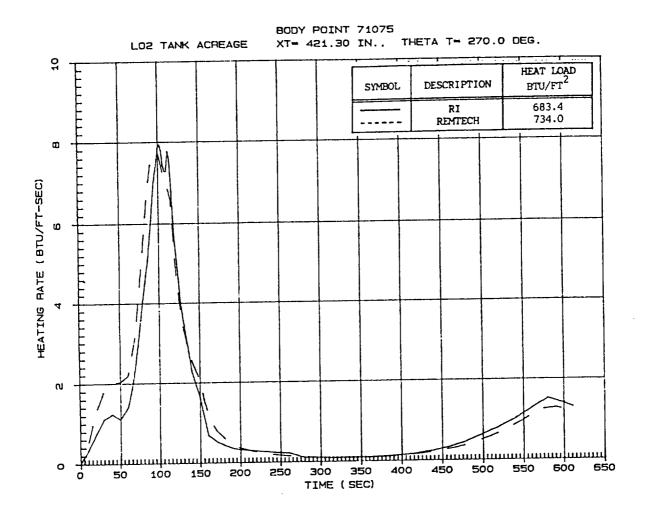


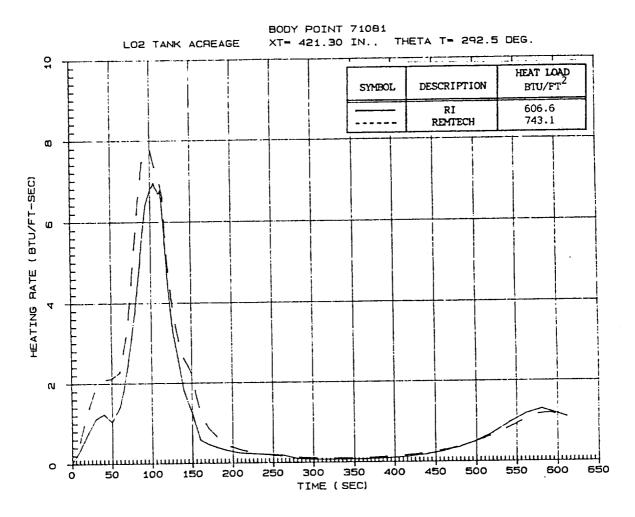


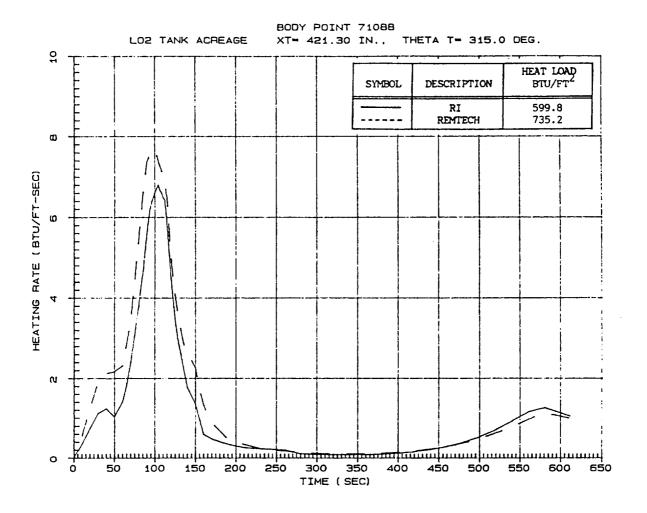


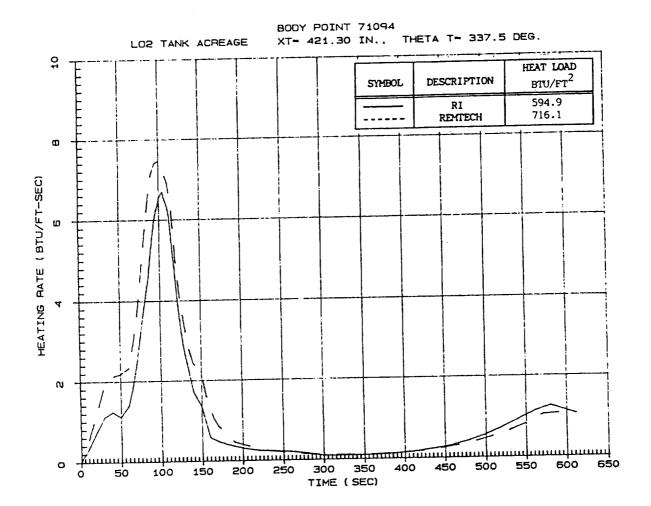


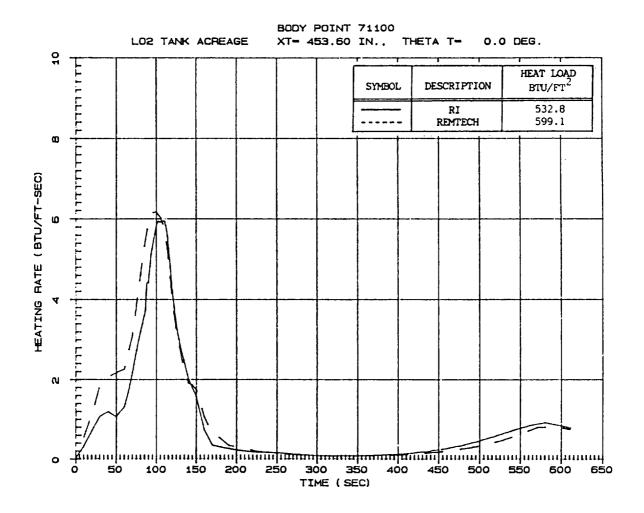


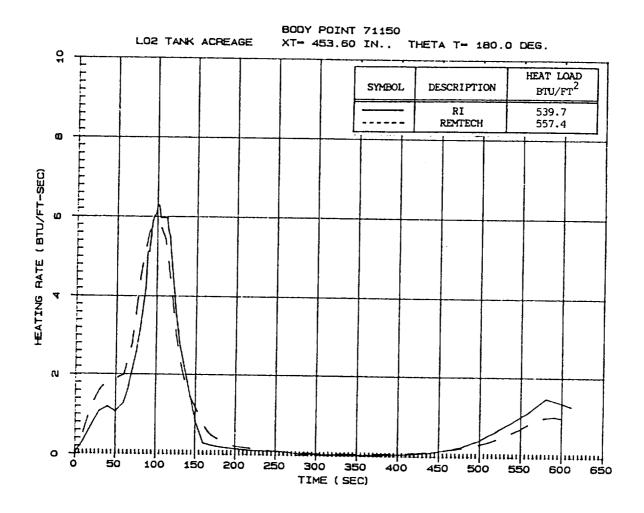


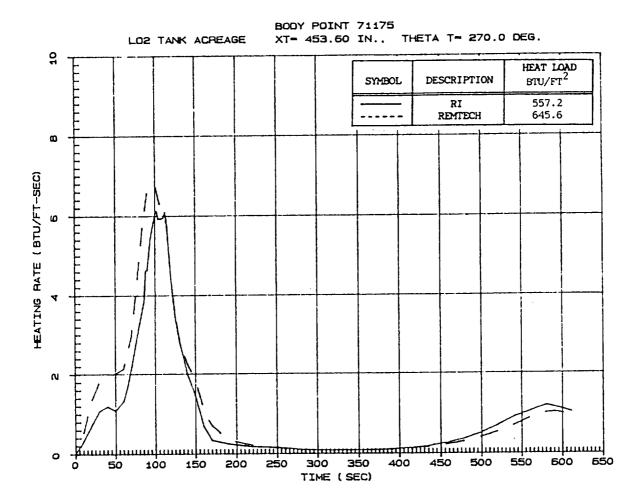


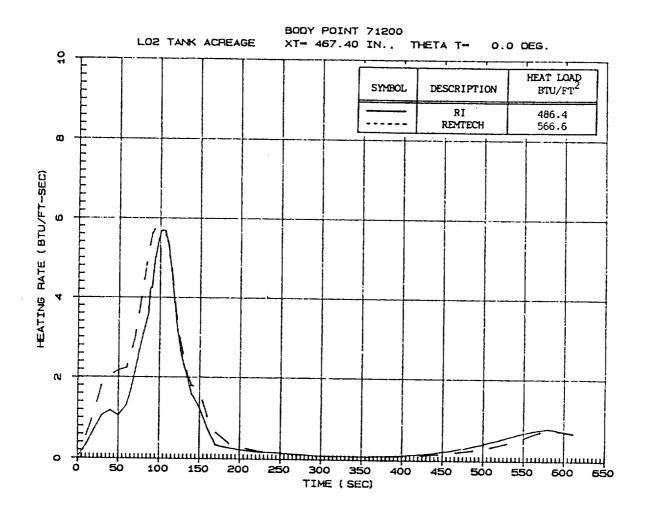


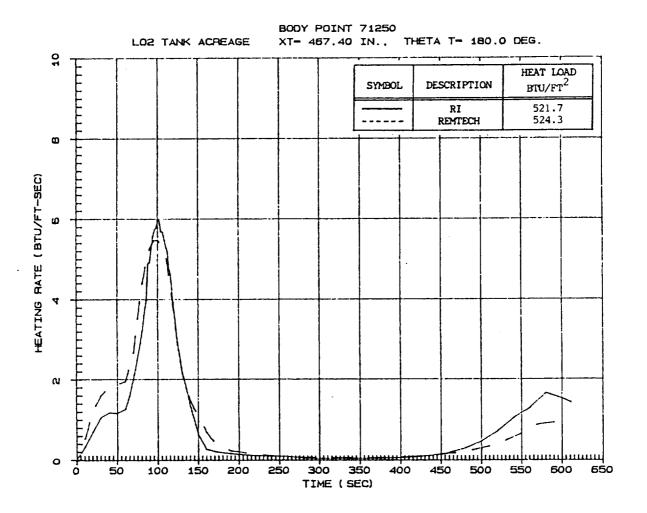


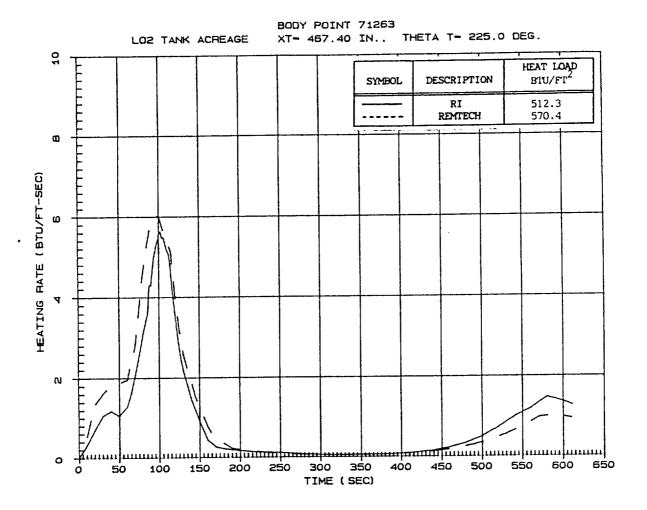


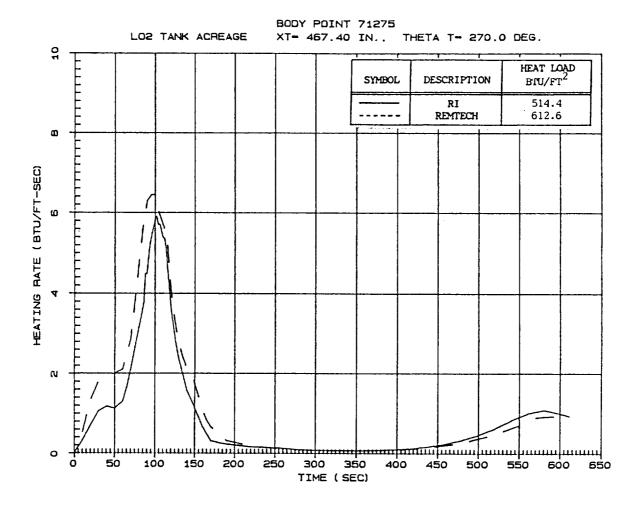


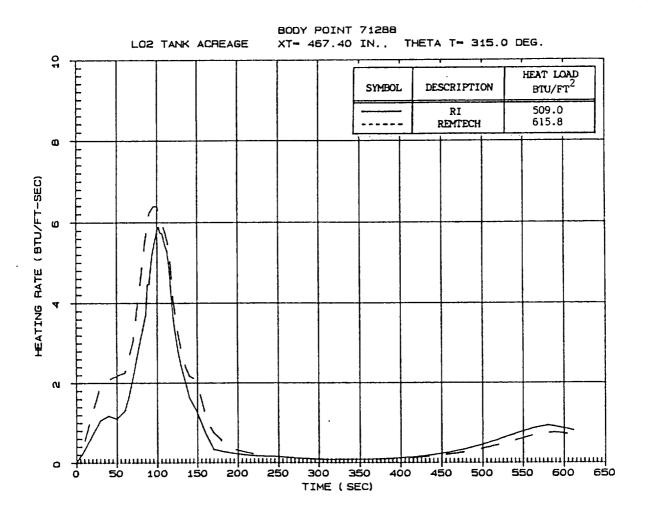


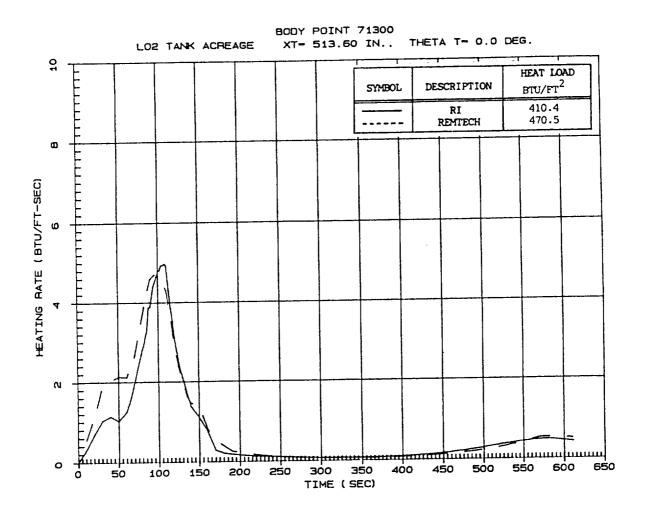


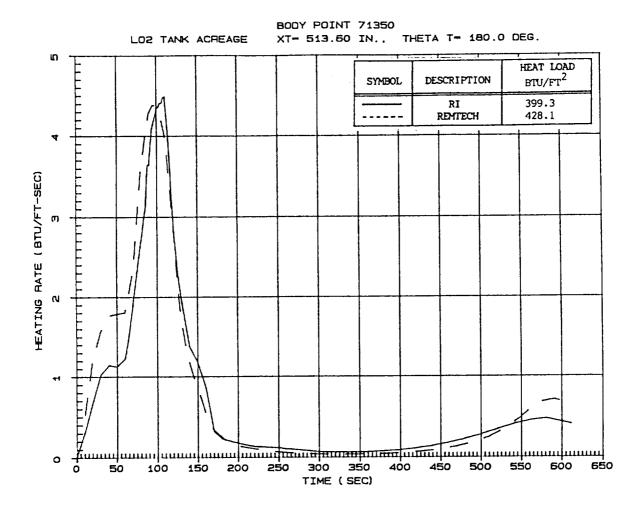


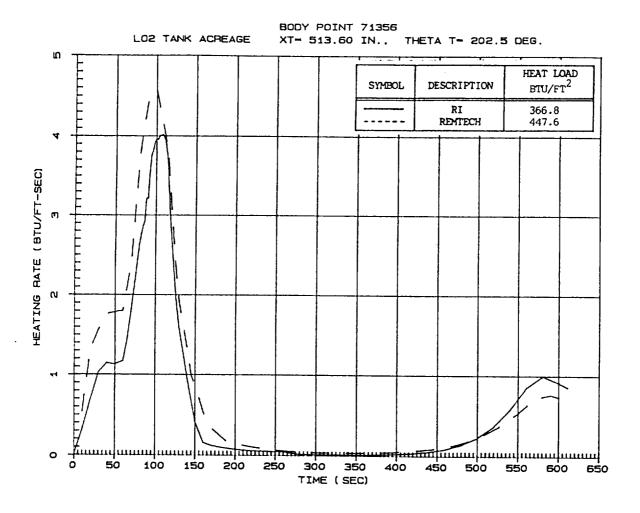


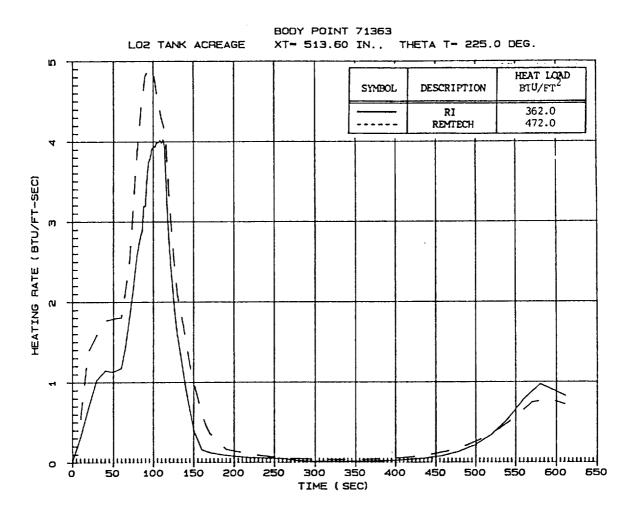




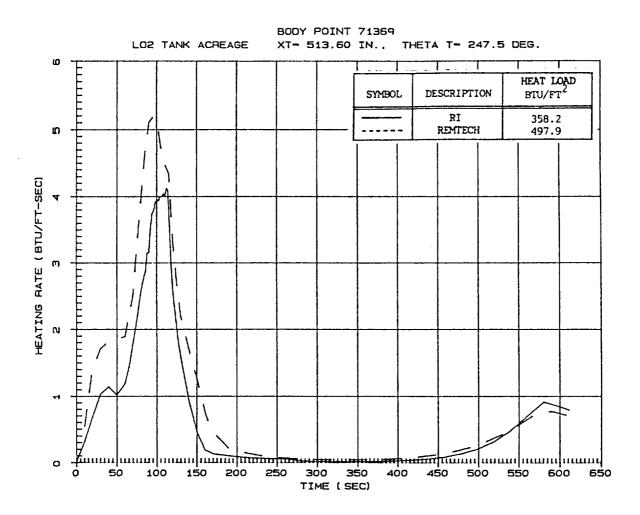




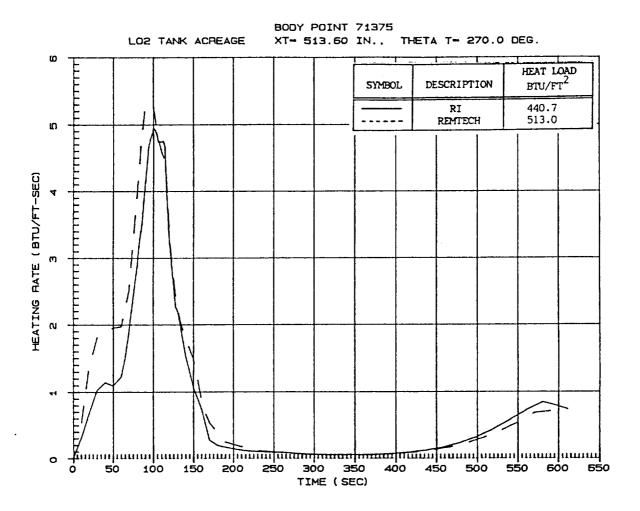


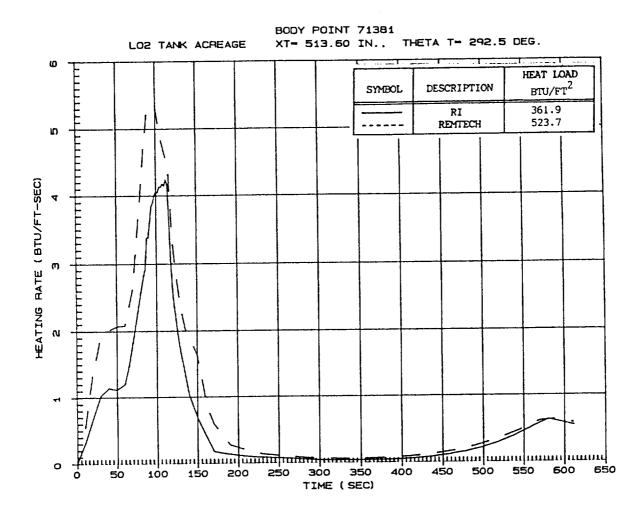


• The difference in max heating rate amounts to  $\sim$  0.1 inches of TPS, well within the allowable application uncertainty of  $\pm$  0.38 inches of CPR.

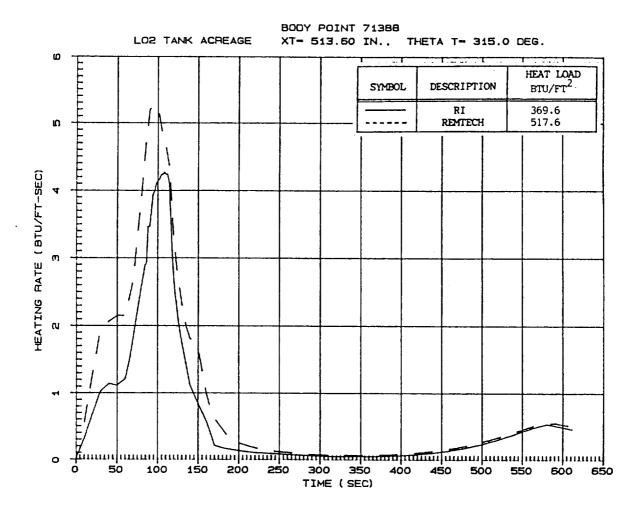


• The difference in maximum heating rate amounts to a difference of  $\sim$  0.1 inches of TPS, well within the allowable application uncertainty of  $\pm$  0.38 inches of CPR.

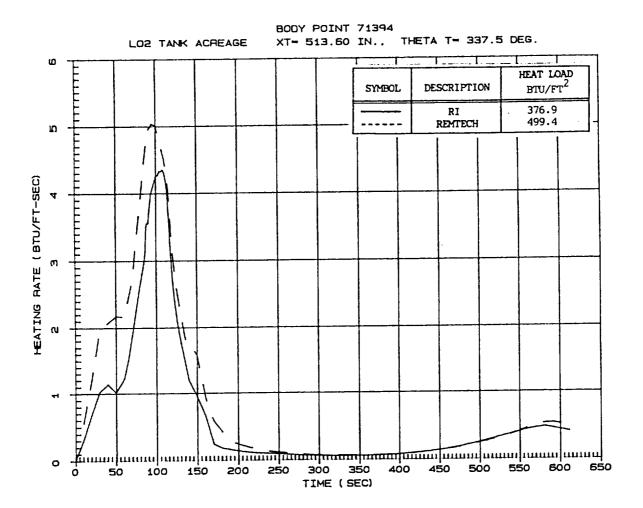




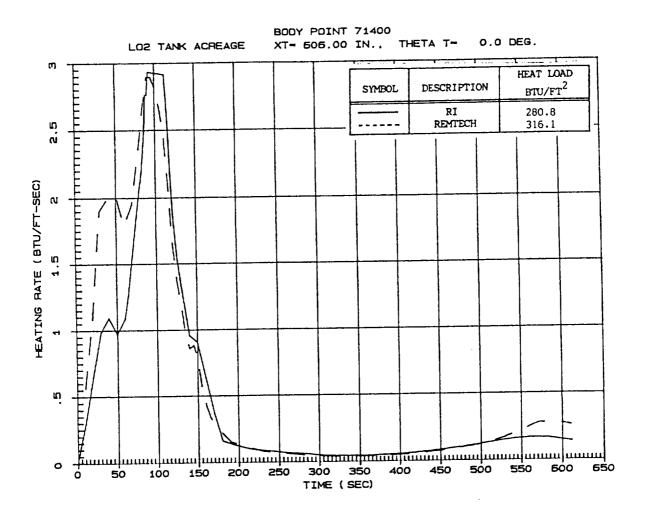
• The difference in max heating rate amounts to  $\sim$  0.1 inches of TPS, well within the allowable application uncertainty of  $\pm$  0.38 inches of CPR.

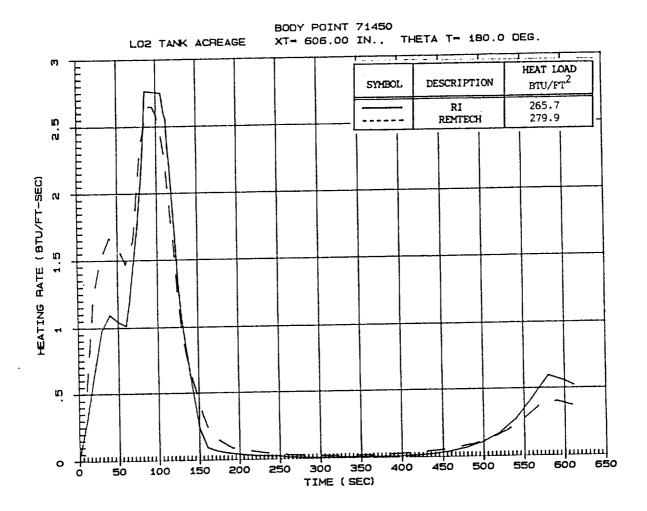


• The difference in max heating rate amounts to  $\sim 0.1$  inches of TPS, well within the allowable application uncertainty of  $\pm$  0.38 inches of CPR.

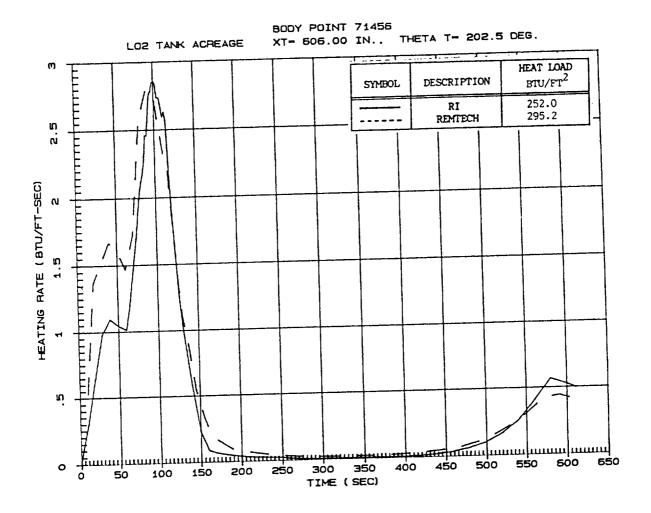


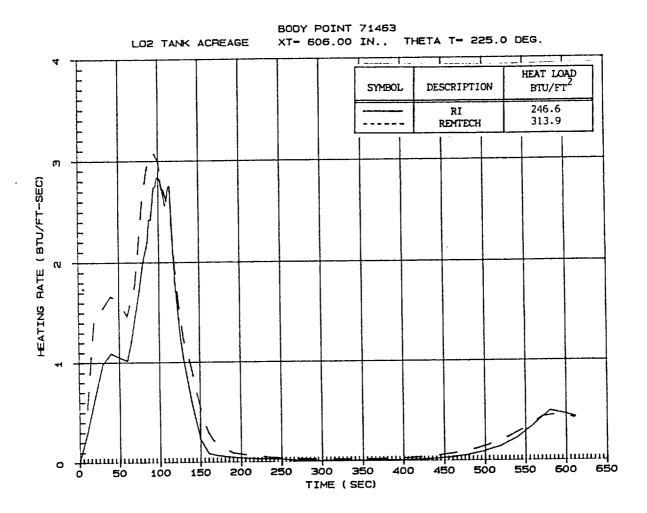
• The difference in max heating rate amounts to < 0.1 inches of TPS, well within the allowable application uncertainty of  $\frac{+}{}$  0.38 inches of CPR.

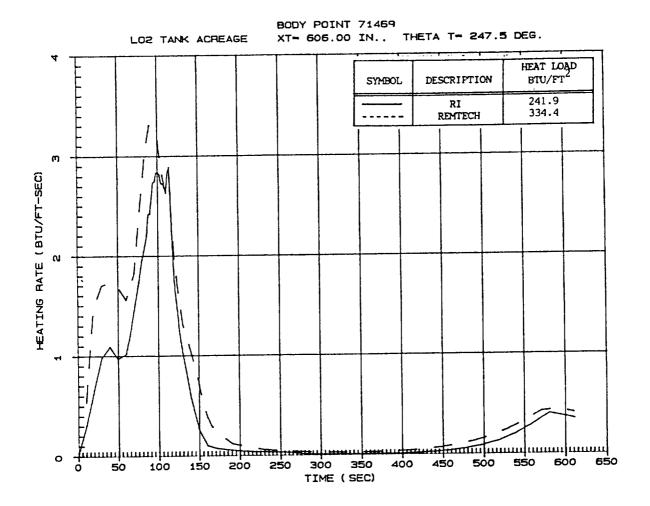


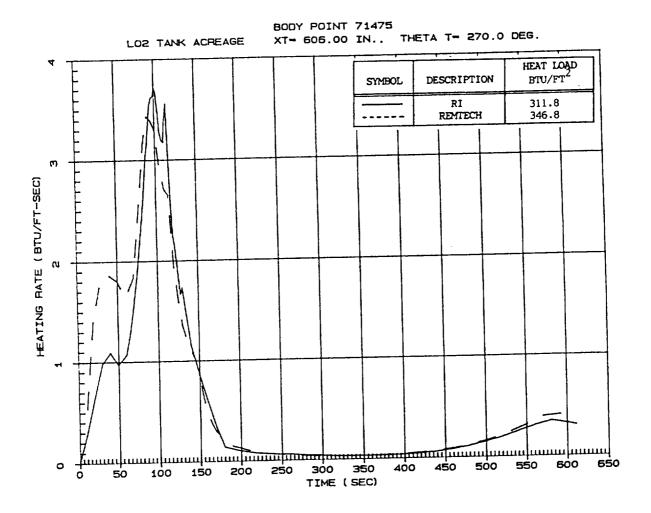


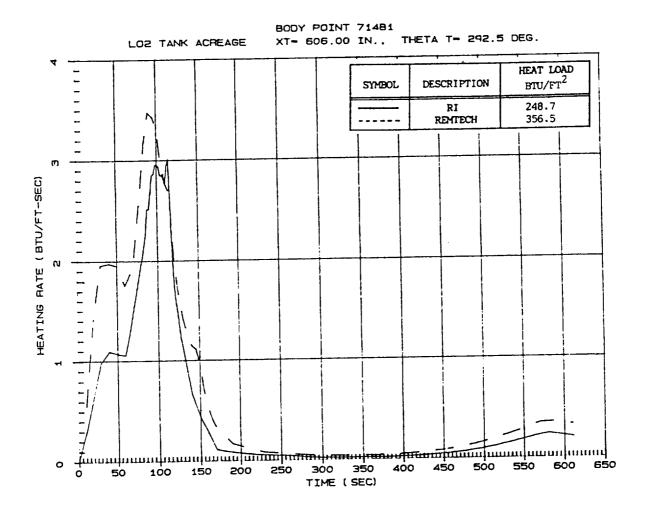
Agreement is acceptable; no TPS impact.

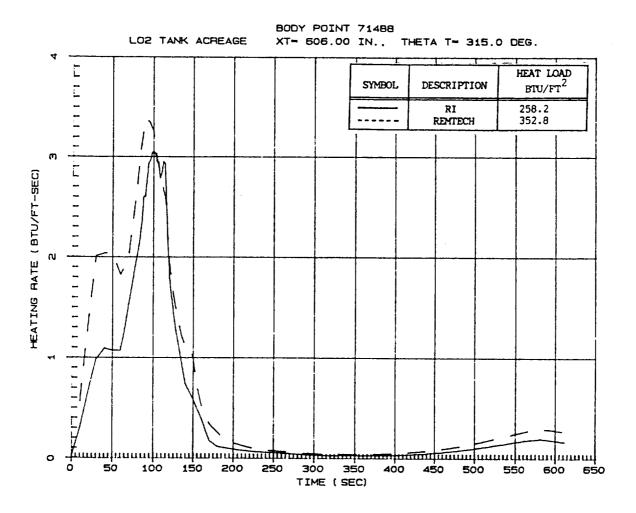




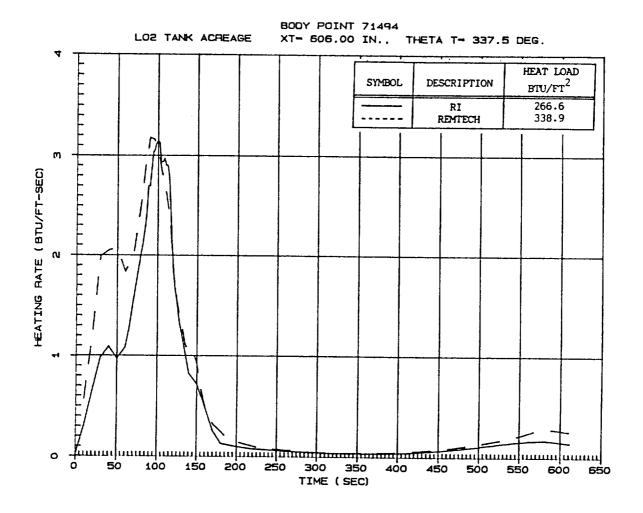




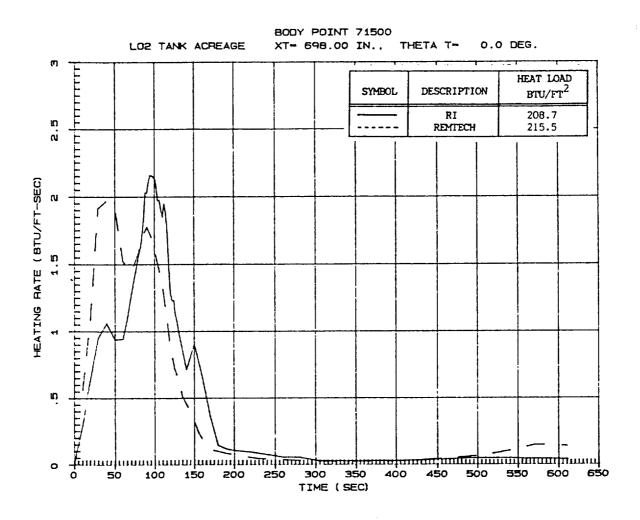


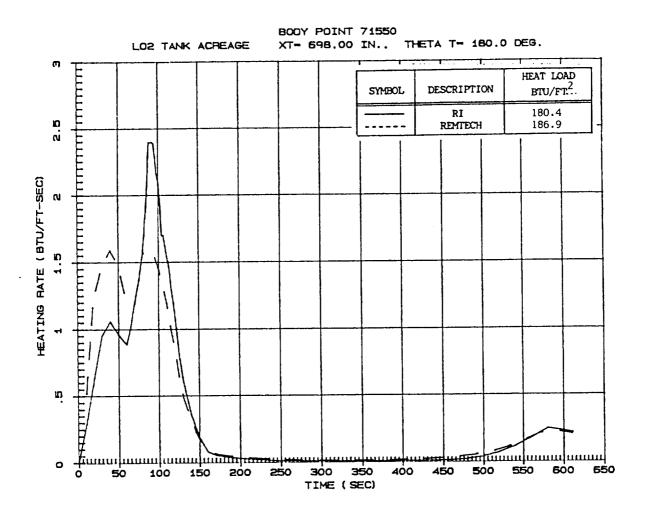


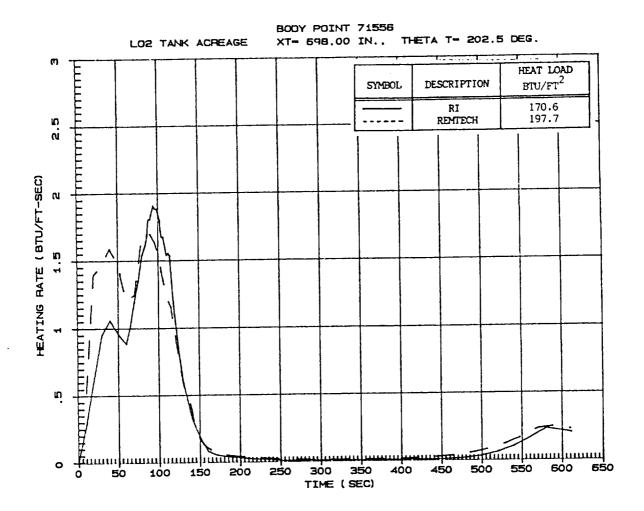
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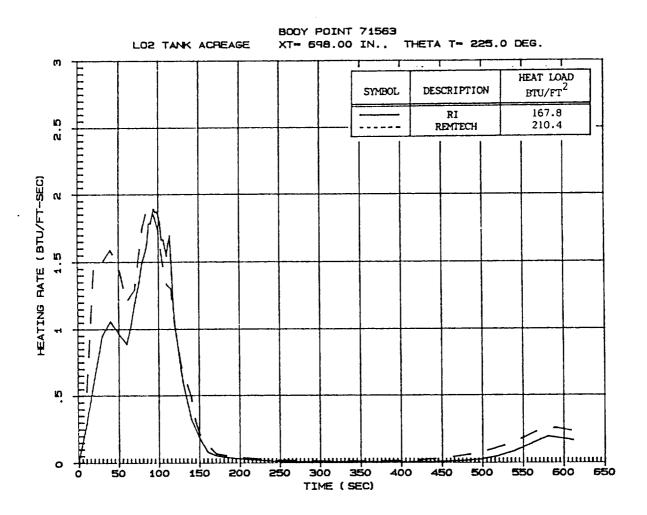


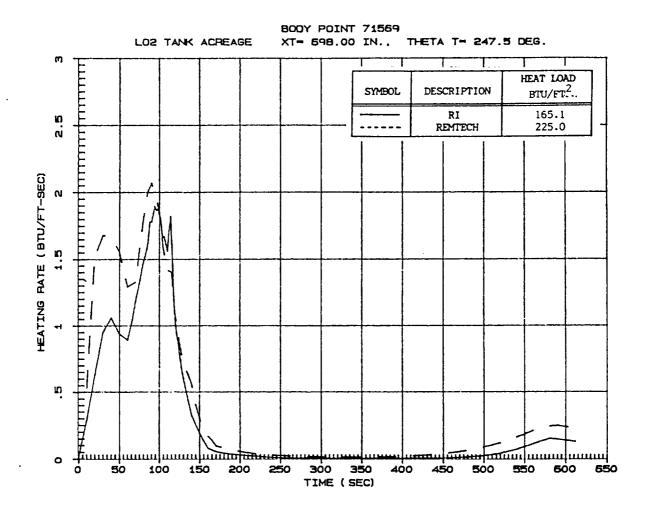
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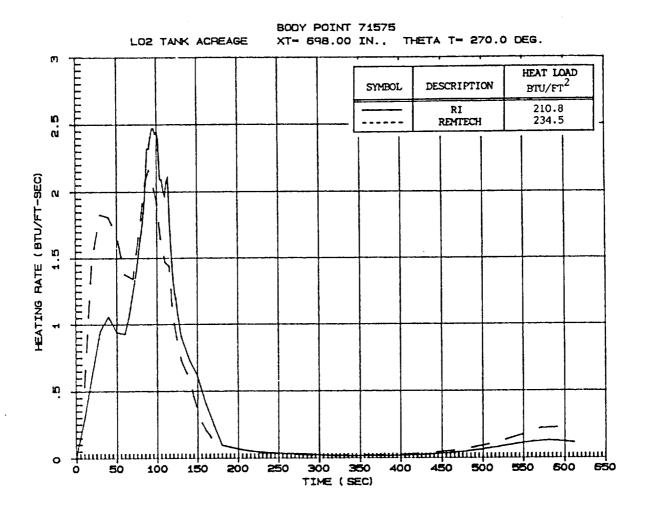


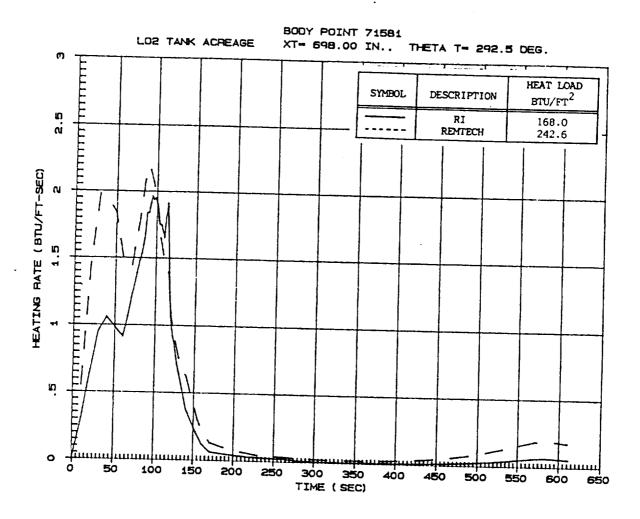


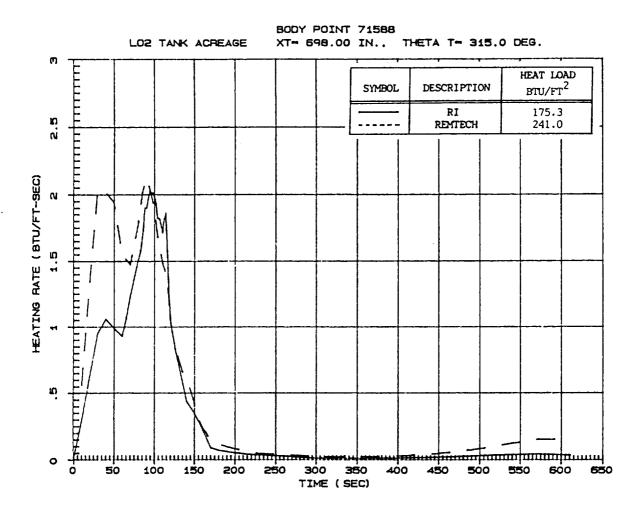


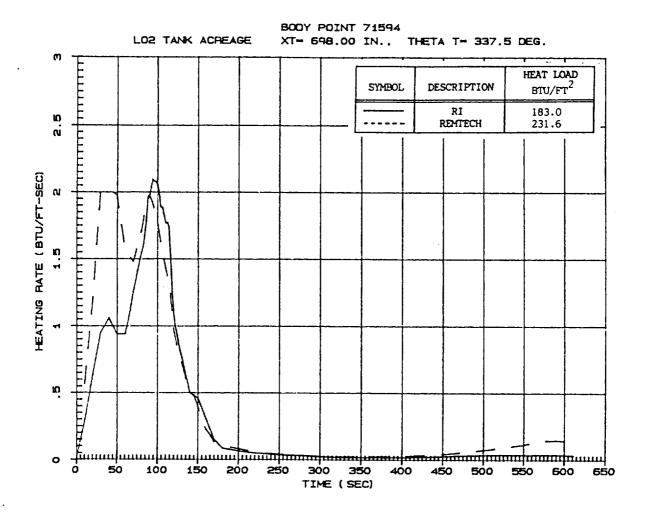


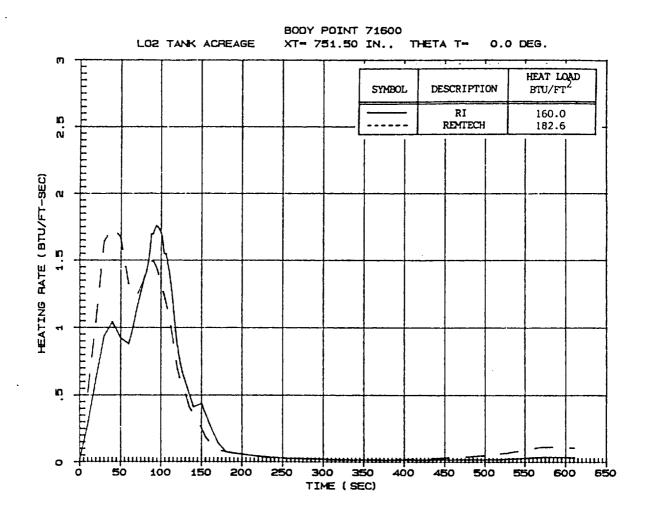


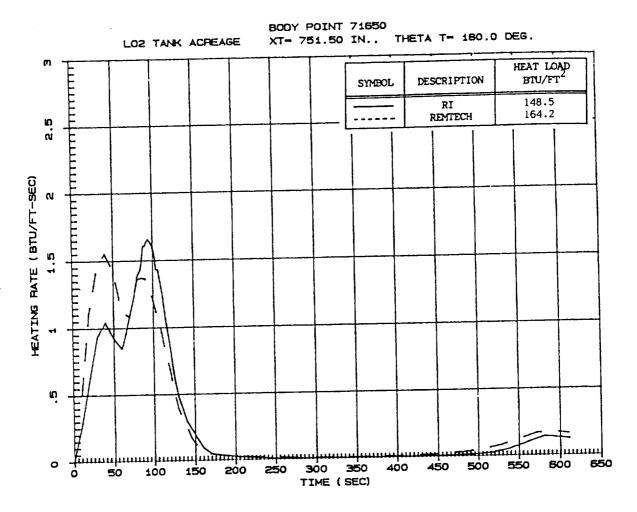


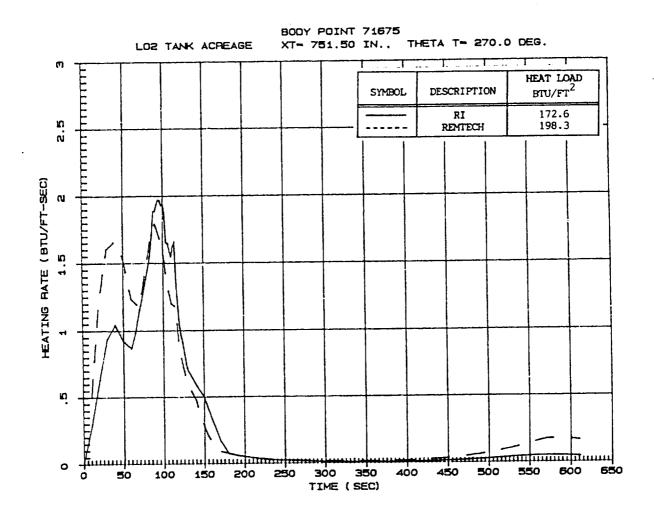


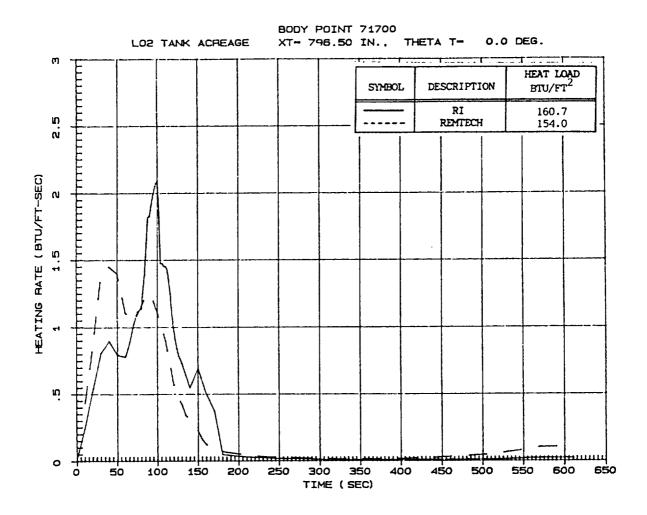


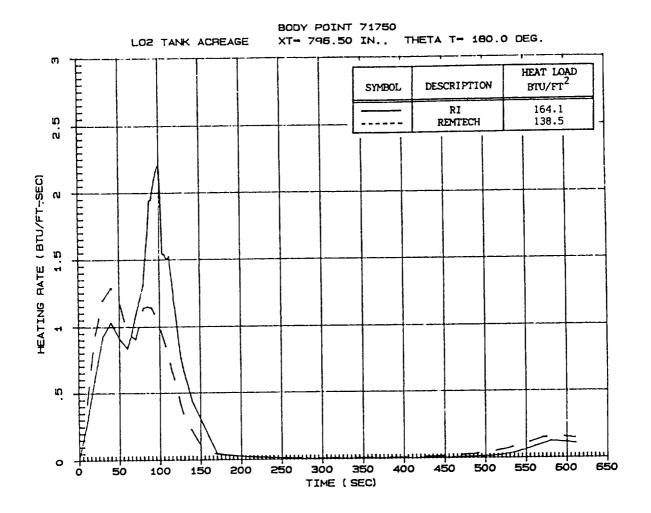


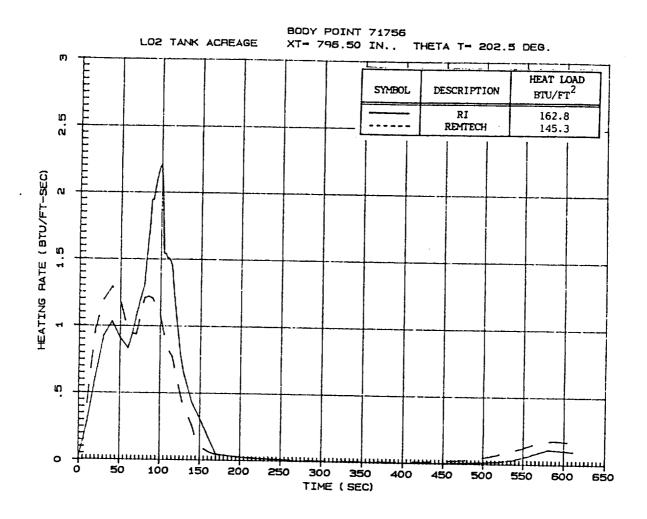


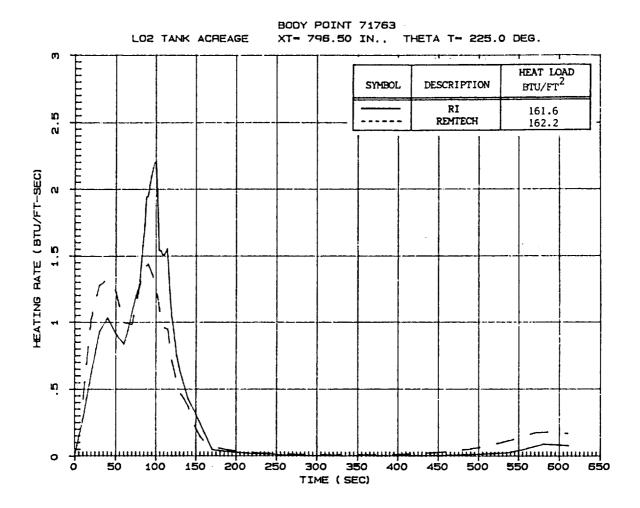


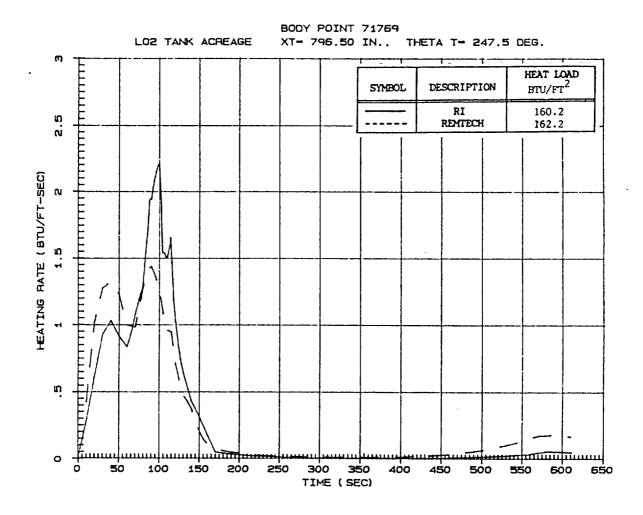


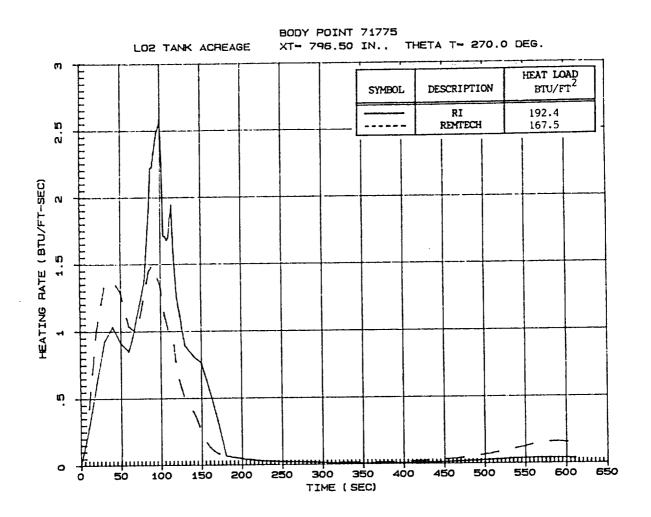


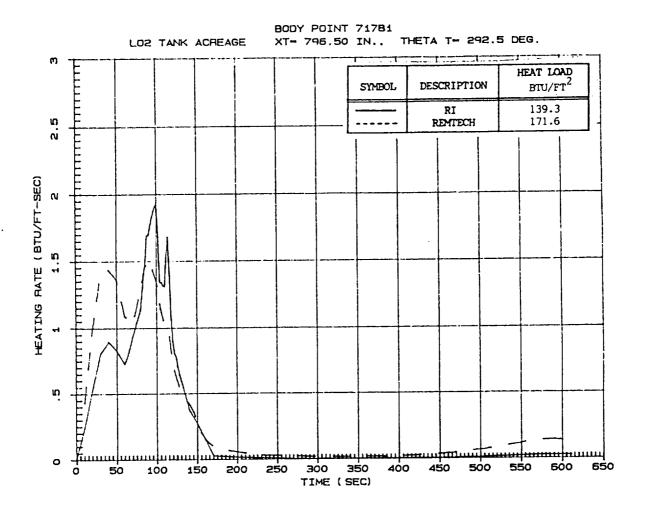


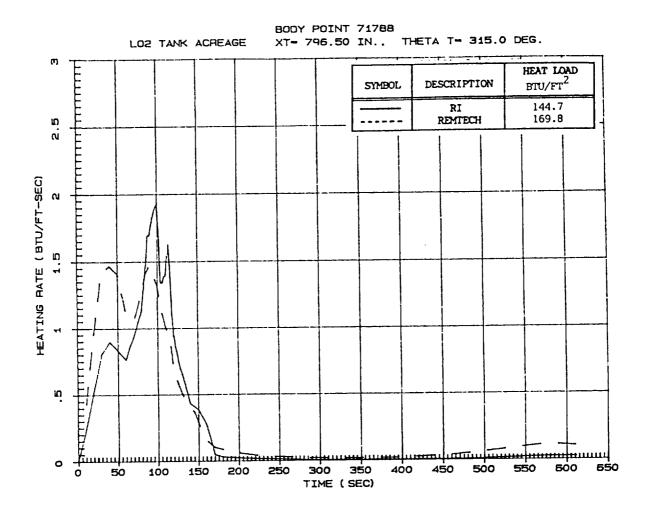


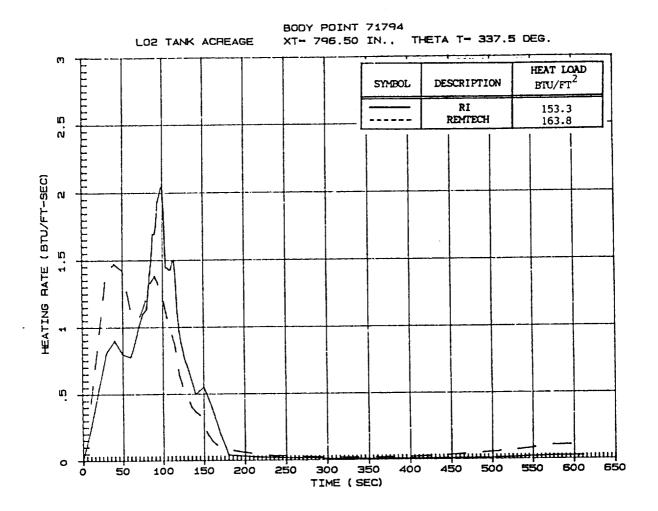




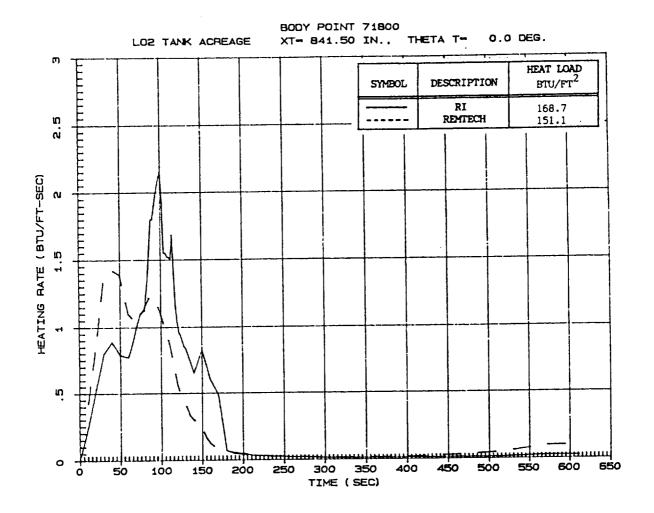


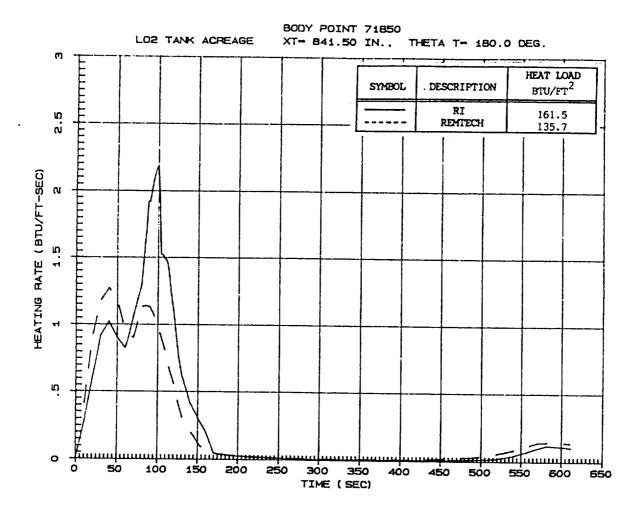




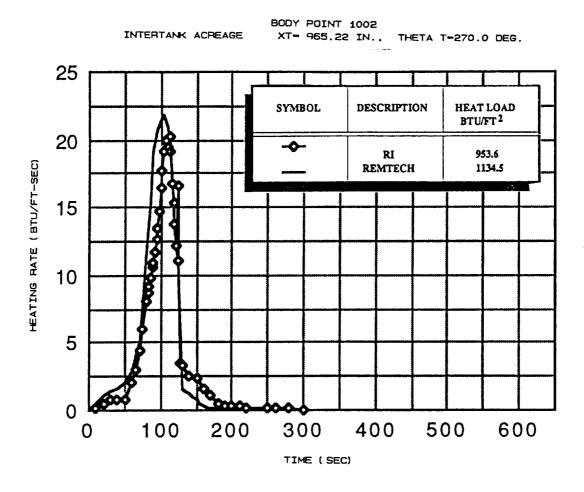


Agreement is acceptable; no TPS impact.

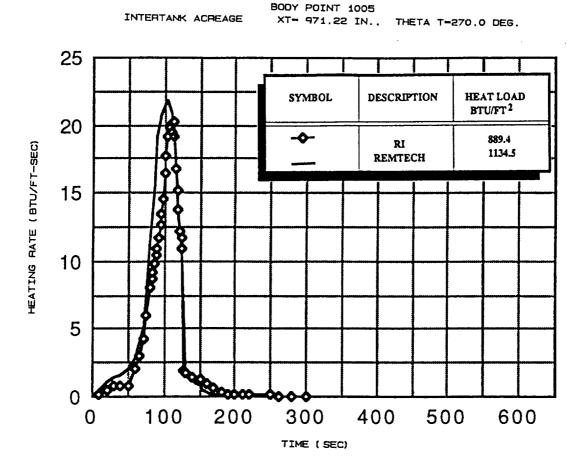




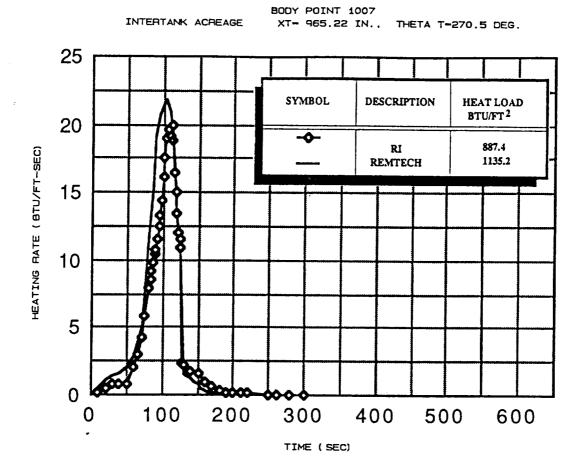
ASCENT DESIGN ENVIRONMENTS FOR THE ET INTERTANK ACREAGE BODY POINTS

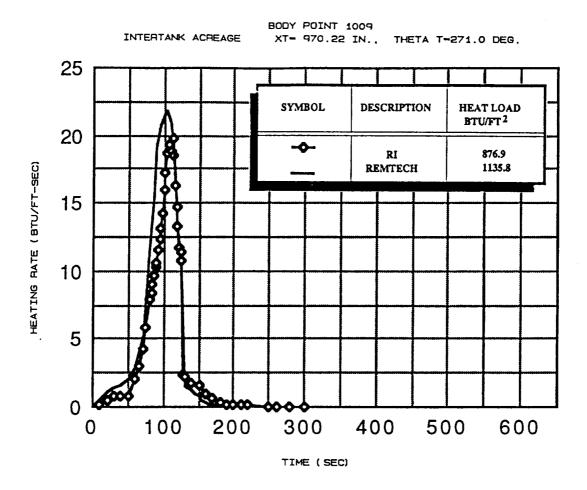


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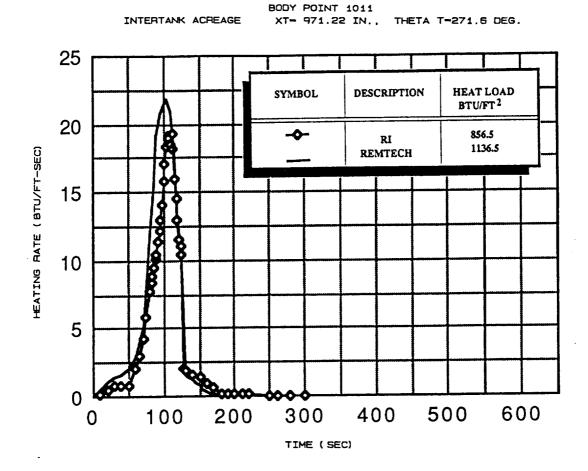


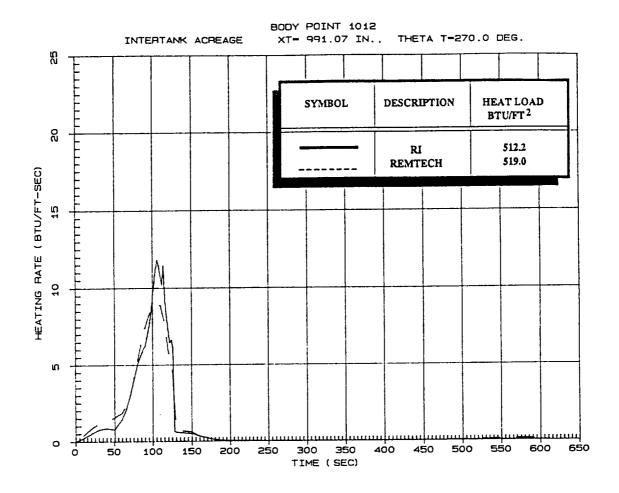
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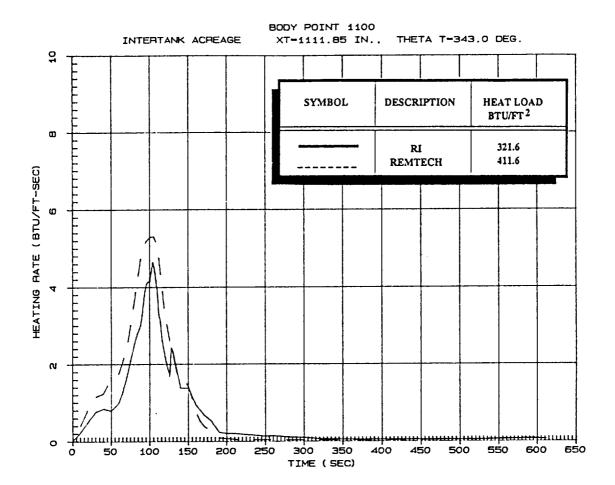




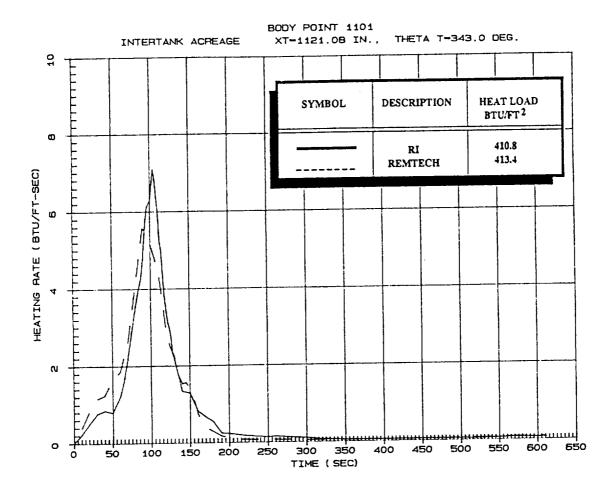
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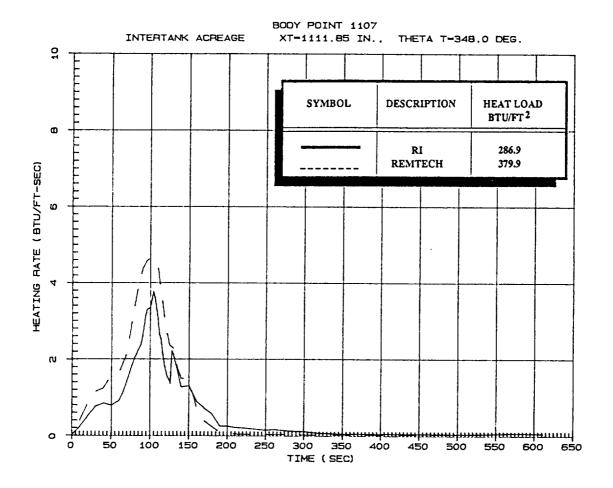




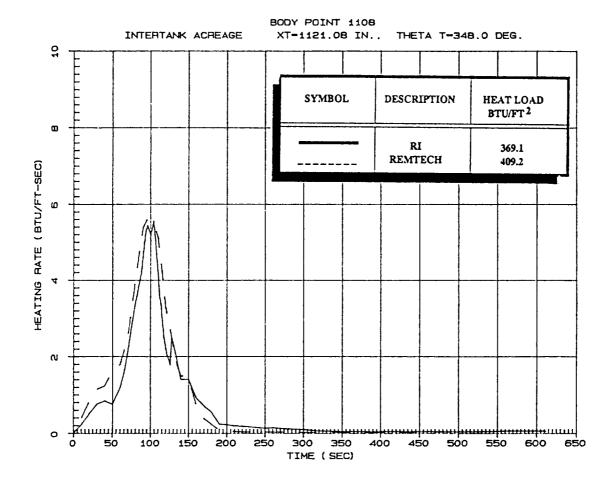


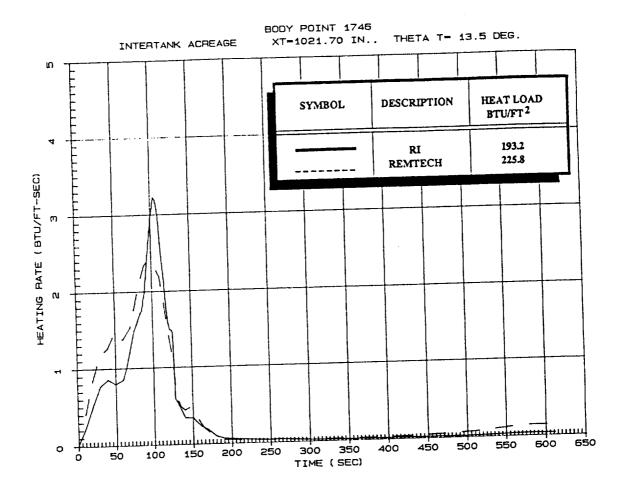
•Difference in heating results in < 0.1 inch of TPS.

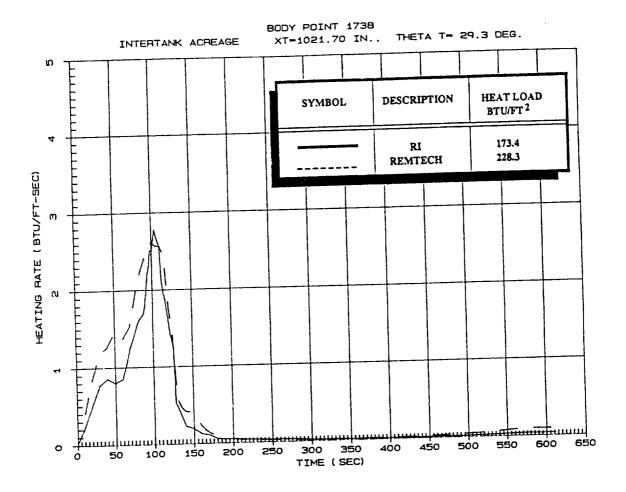


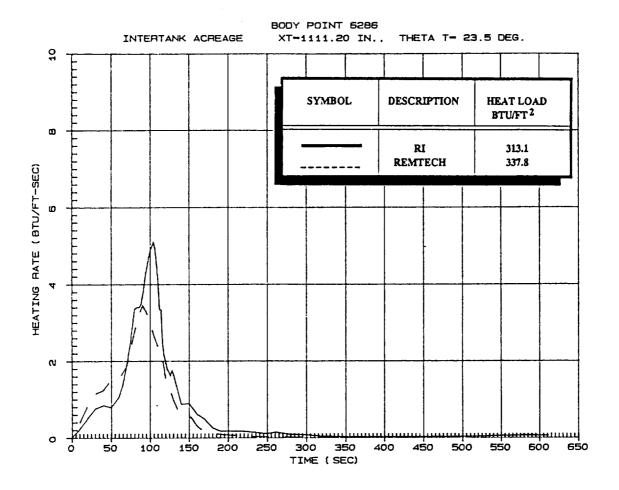


•Difference in heating results in < 0.1 inch of TPS.



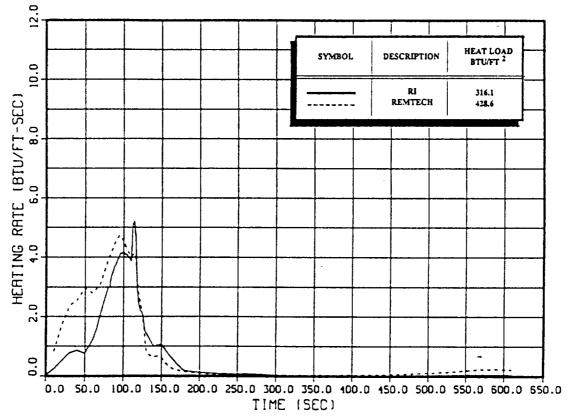


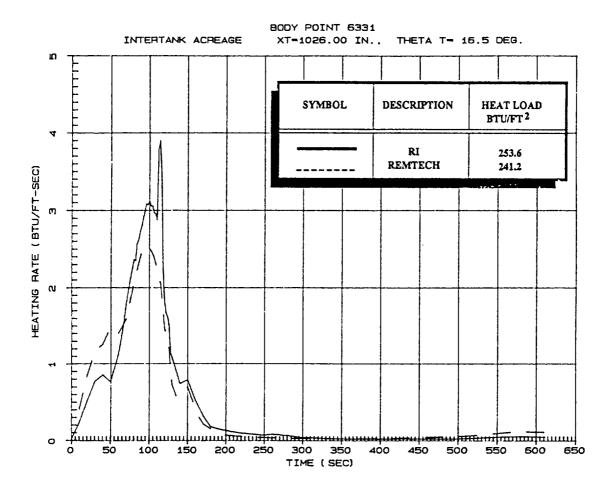


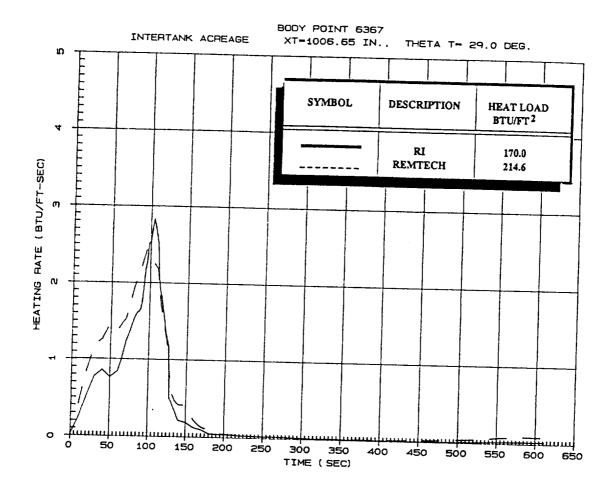


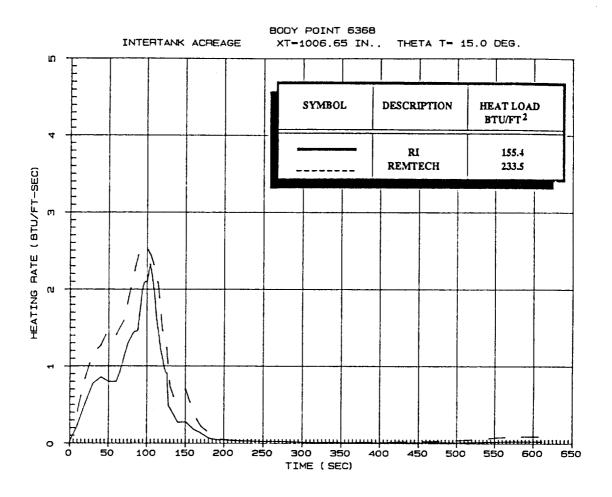
BODY POINT 6301

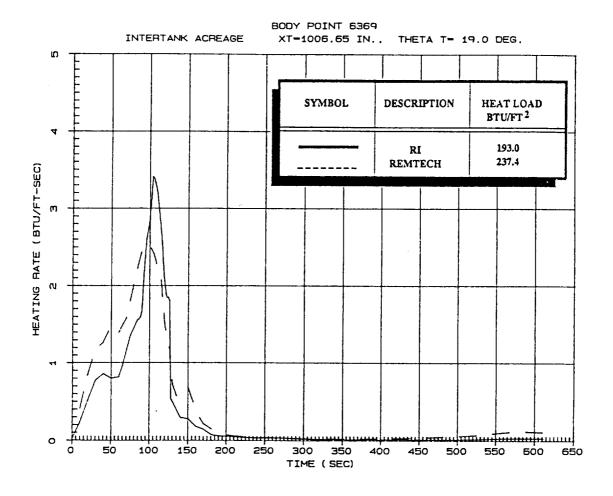
INTERTANK ACREAGE XT - 983.5 IN. THETA T - 23.5 DEG.

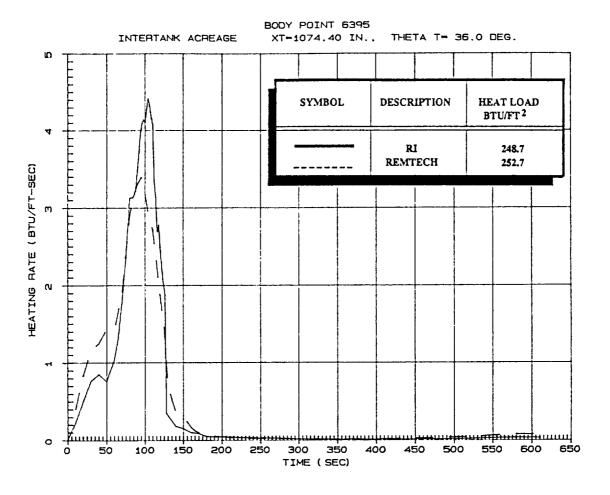


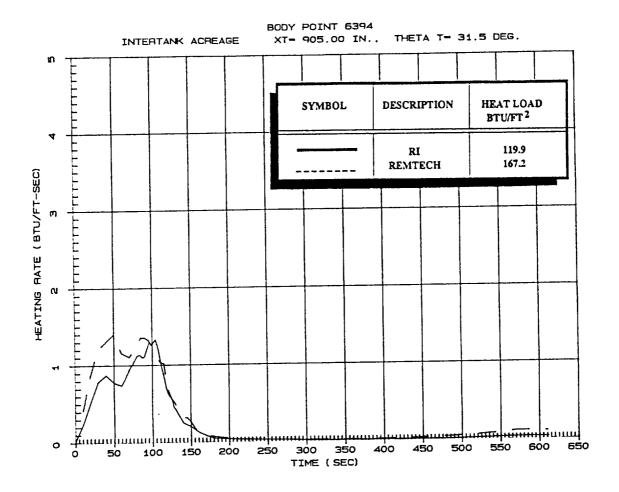


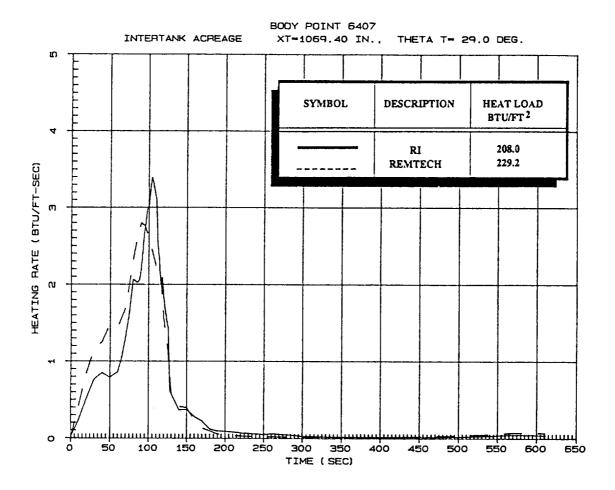


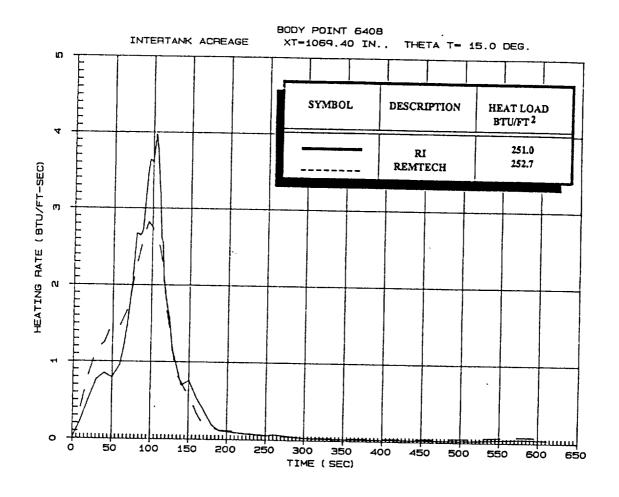


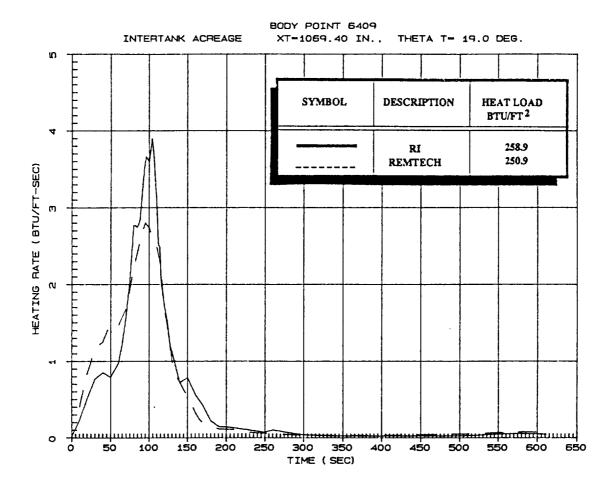


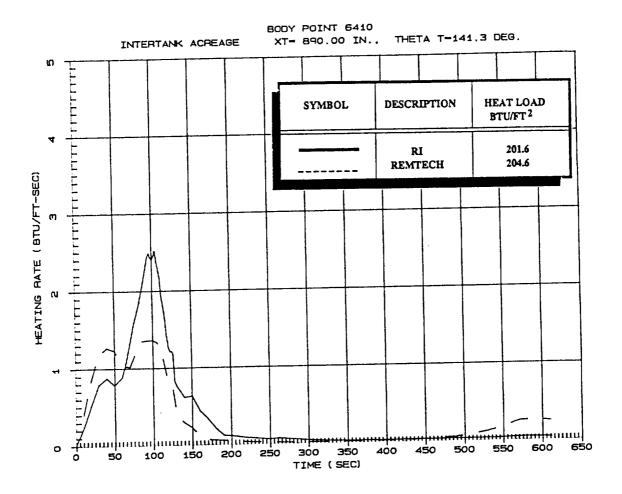


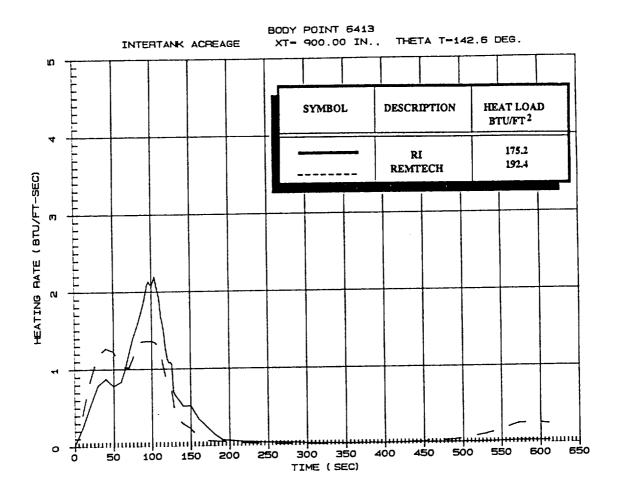


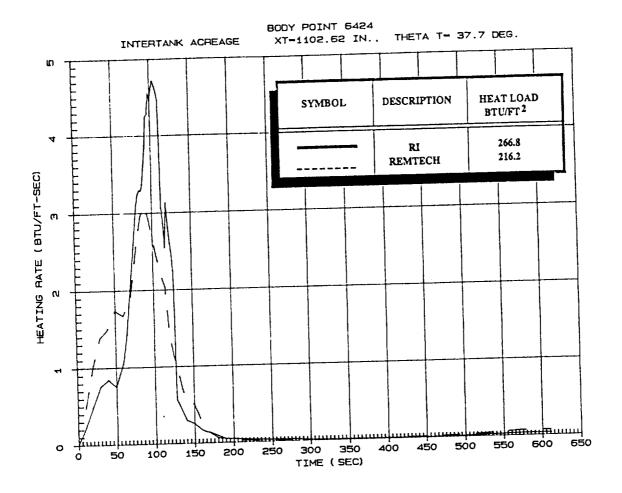


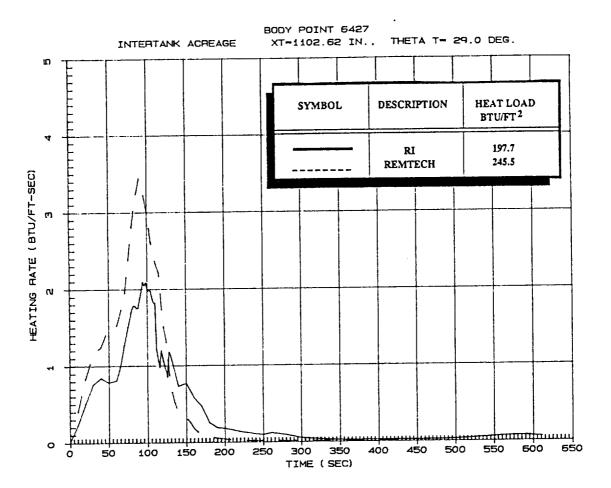




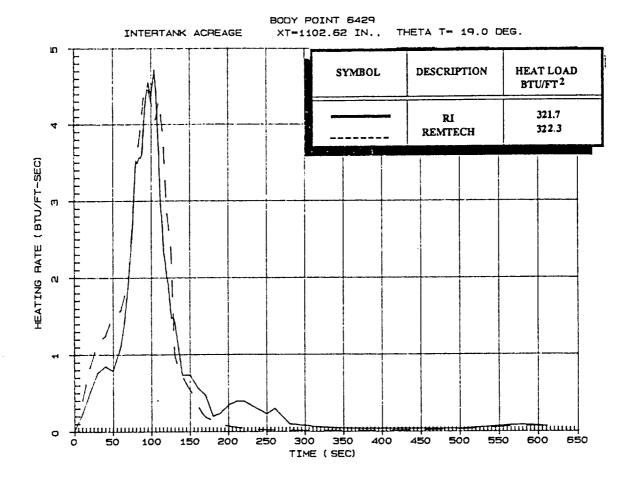


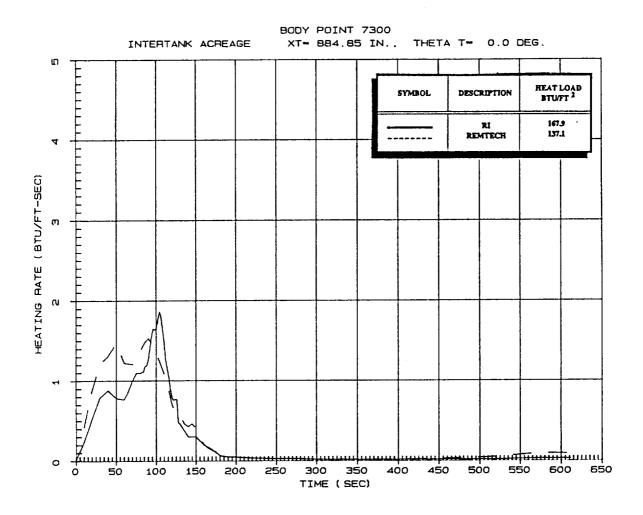


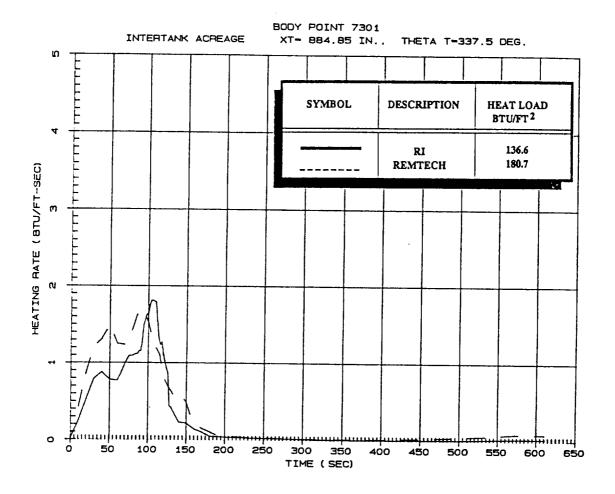


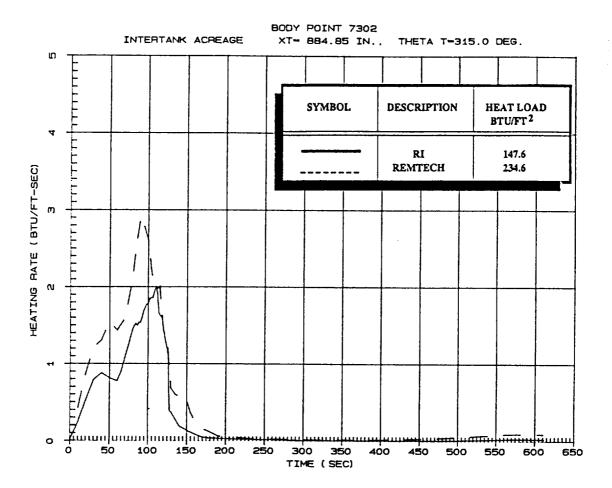


• Difference in heating results in  $\sim$  0.1 inch of TPS, i.e., within application tolerance.

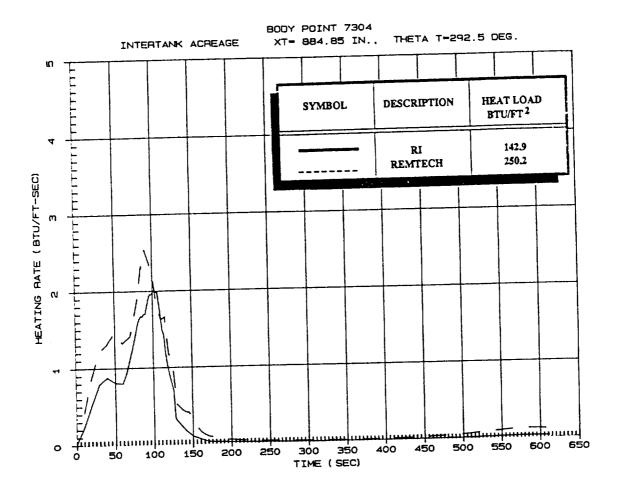


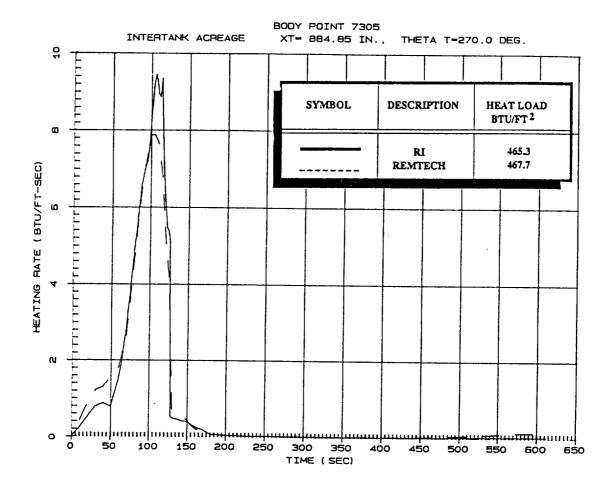


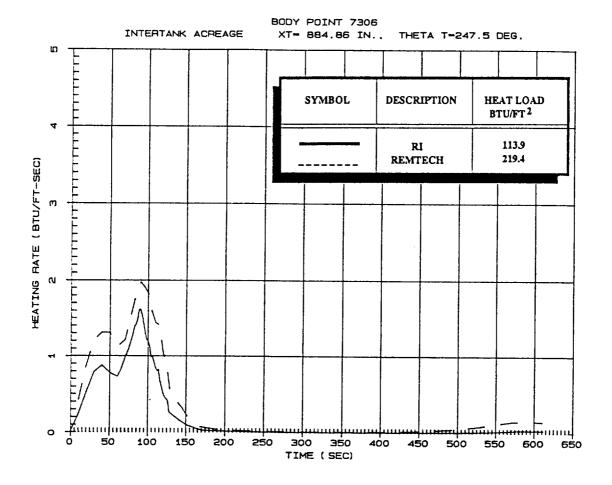


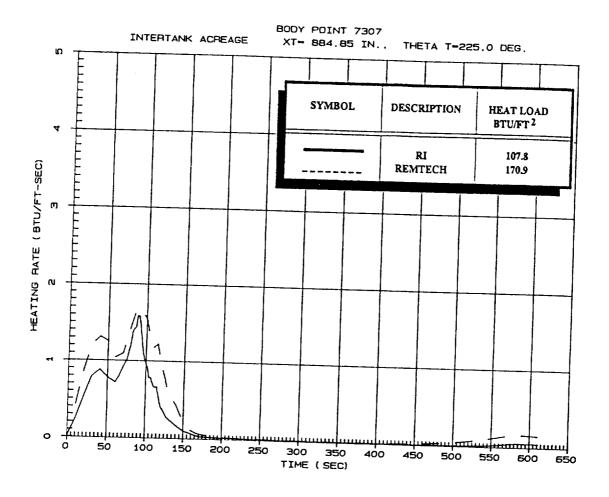


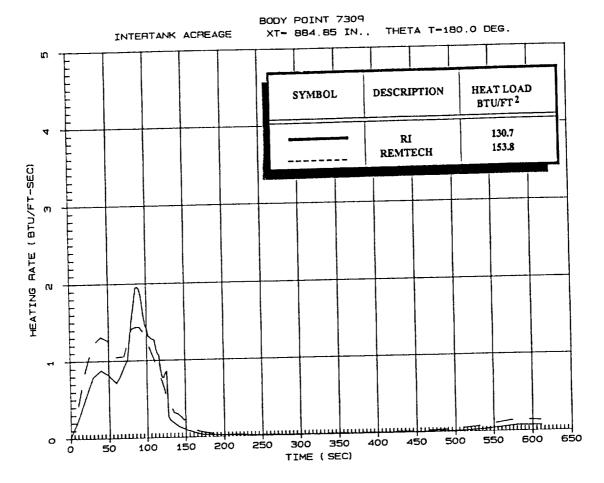
• Difference in heating results in  $\sim$  0.1 inch of TPS, i.e., within application tolerance.

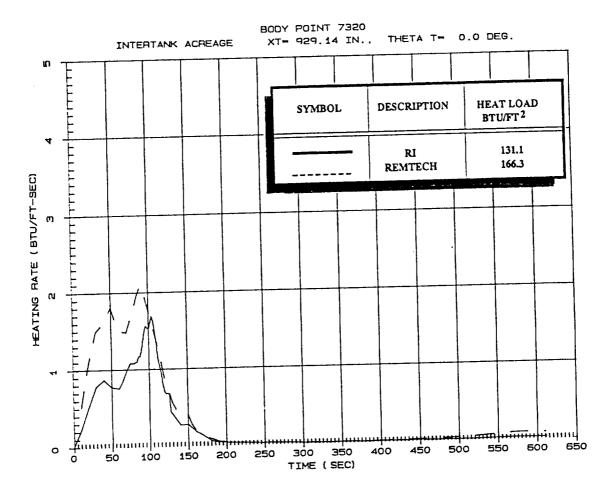




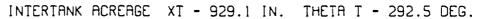


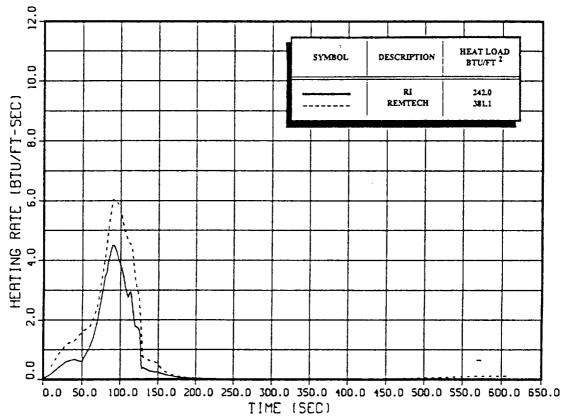




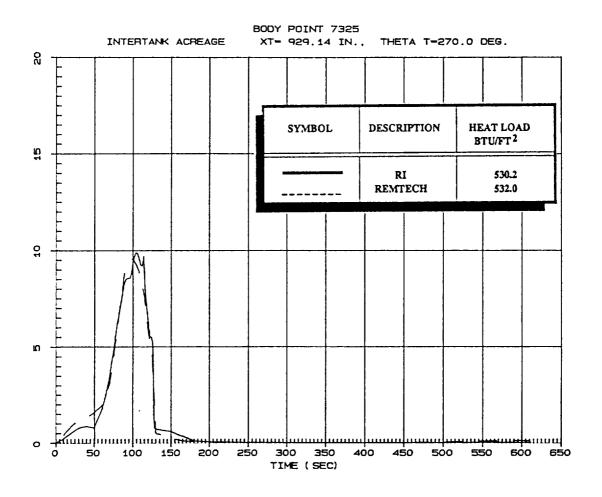


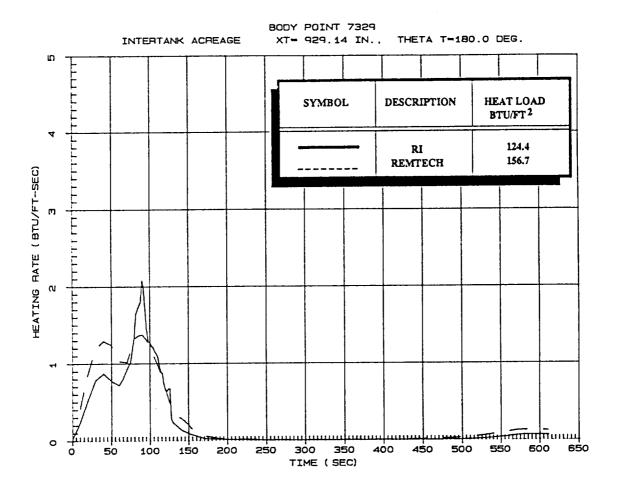
BODY POINT 7324





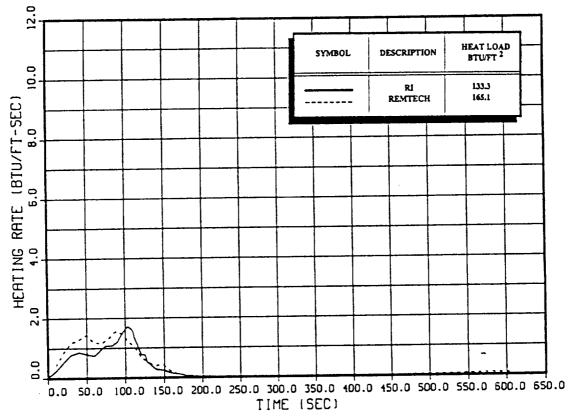
• Difference in heating results in  $\sim$  0.1 inch of TPS, i.e., within application tolerance.



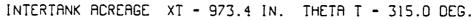


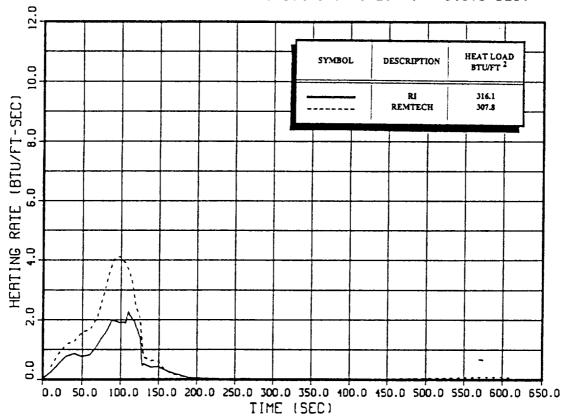
BOOY POINT 7350

INTERTANK ACREAGE XT - 973.4 IN. THETA T - 0.0 DEG.



BODY POINT 7352

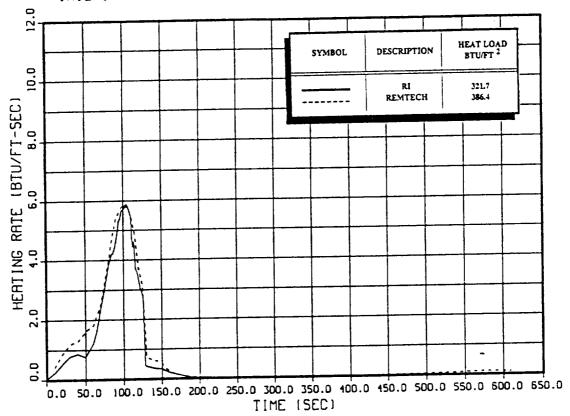


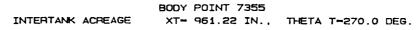


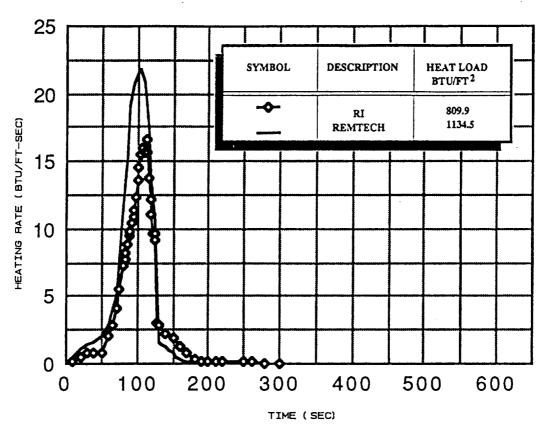
•Difference in heating results in  $\sim$  0.1 inch of TPS, i.e., within application tolerance.

BODY POINT 7354

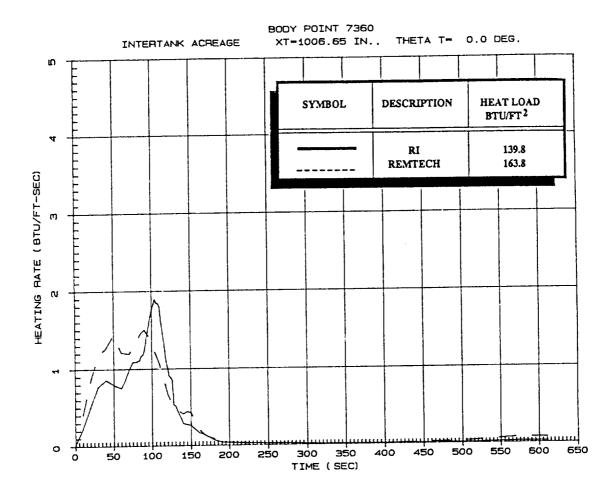
INTERTANK ACREAGE XT - 973.4 IN. THETA T - 292.5 DEG.



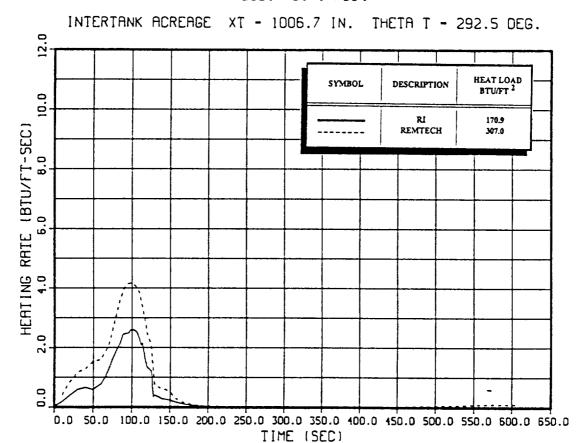




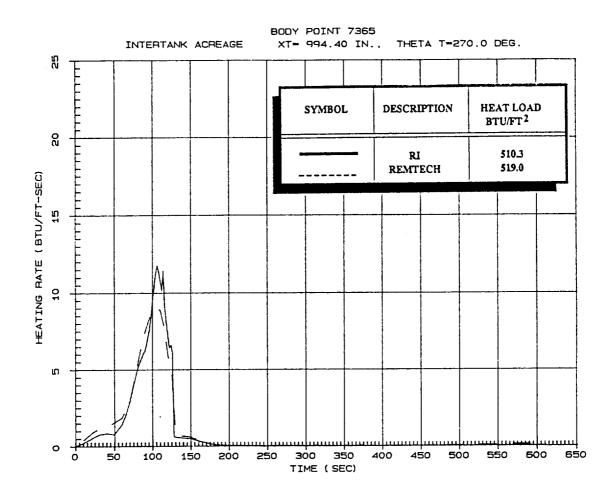
- •RI IVBC-3 low. Calculated without stringer factor.
- Potential TPS impact.



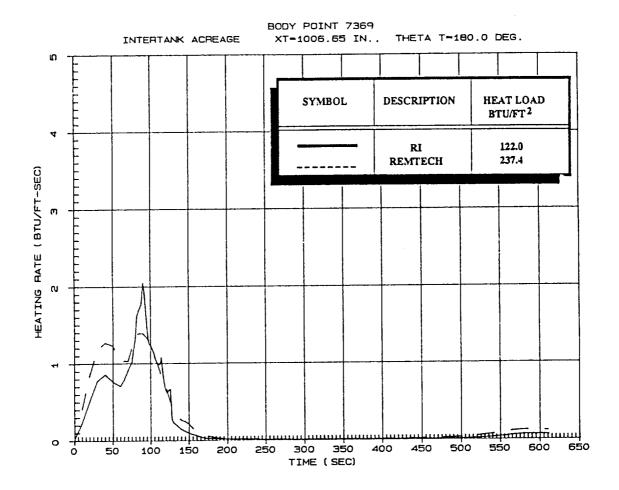
BODY POINT 7364

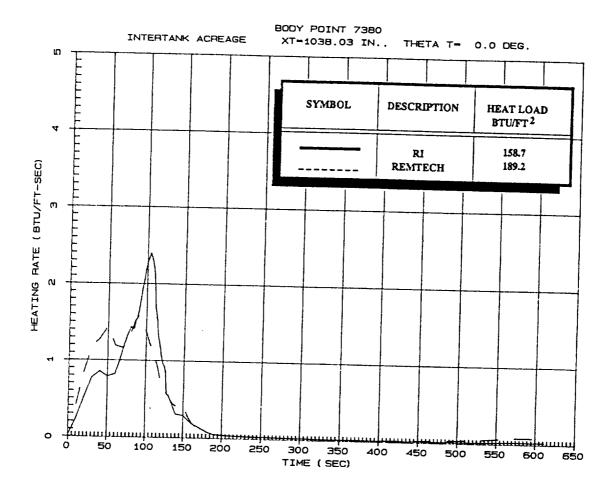


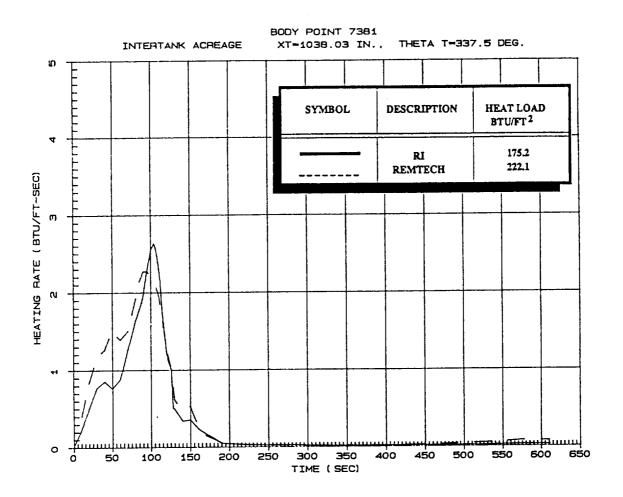
• Difference in heating results in  $\sim$  0.1 inch of TPS, i.e., within application tolerance.

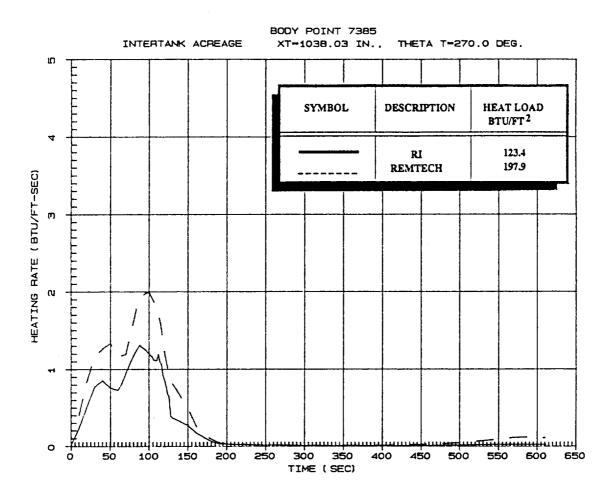


Agreement is acceptable; no TPS impact.

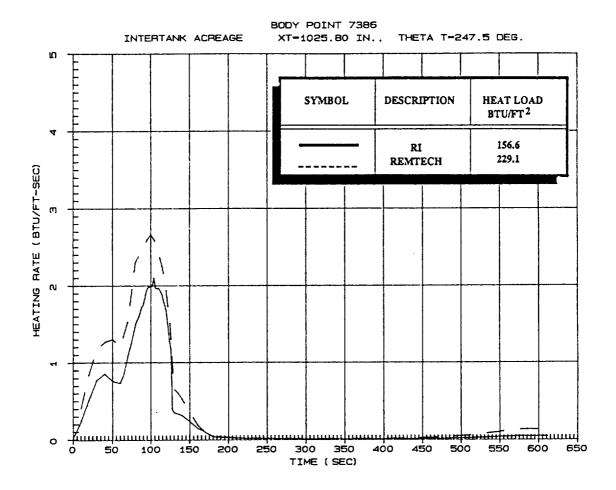


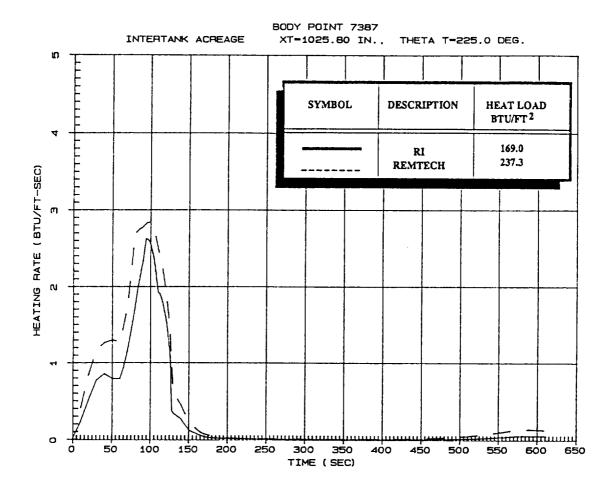


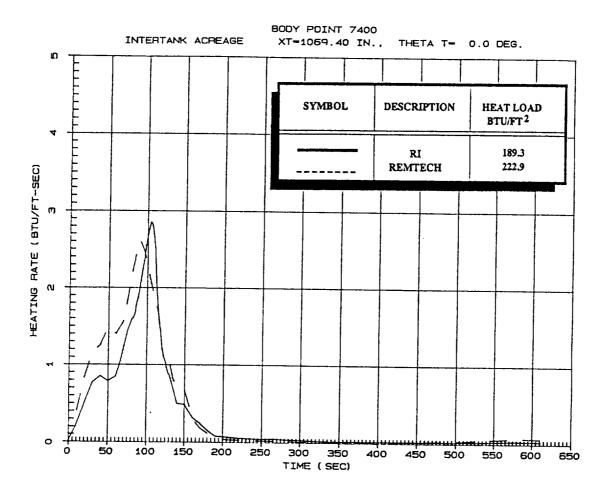


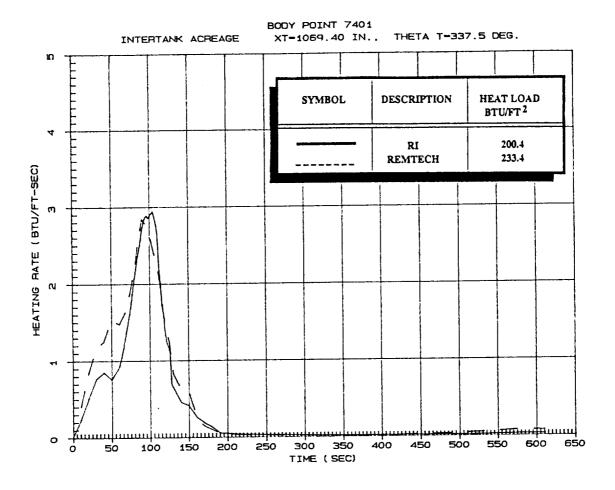


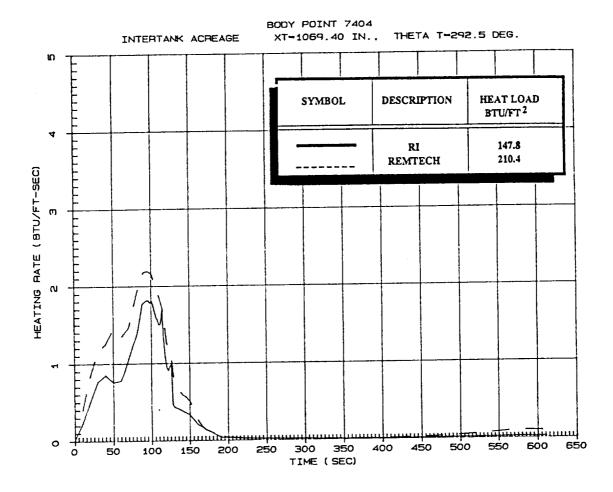
•Difference in heating results in < 0.1 inch of TPS.

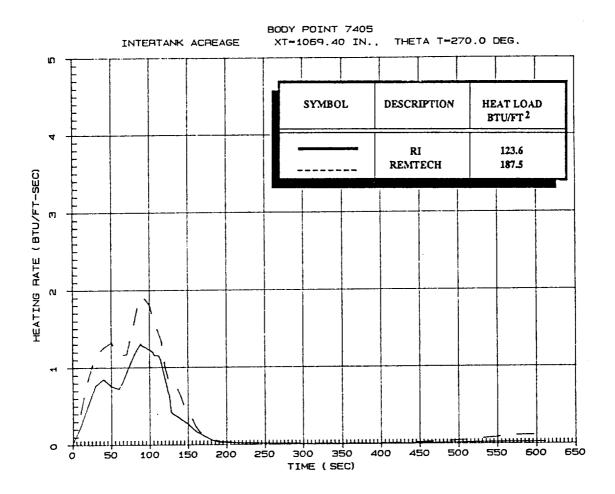


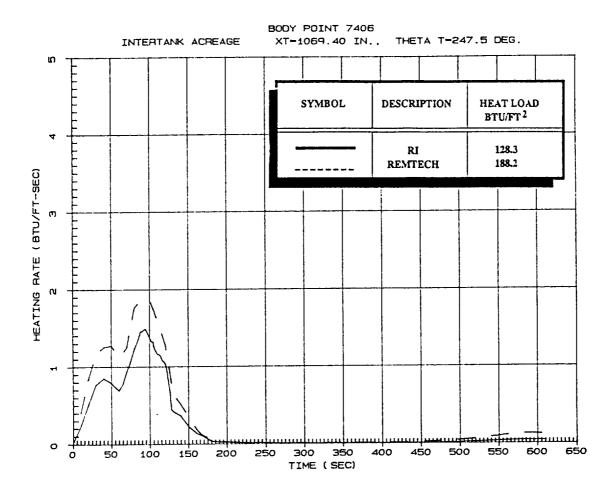


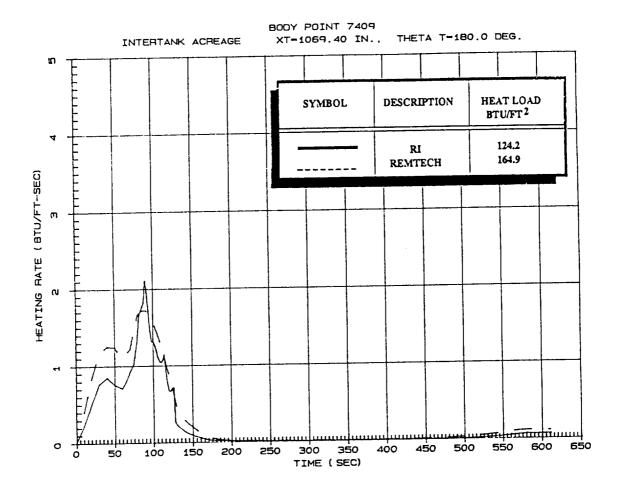


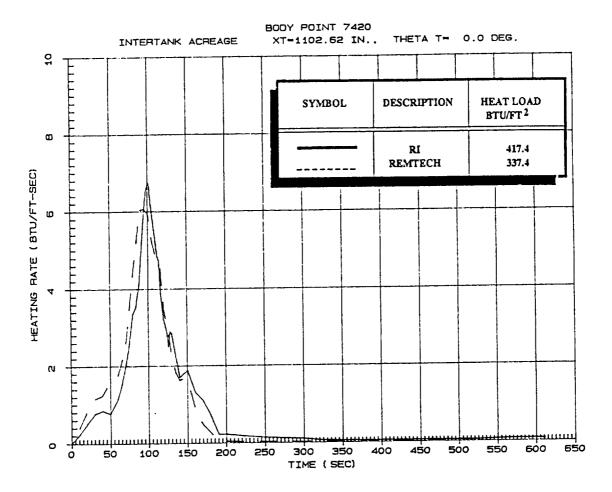


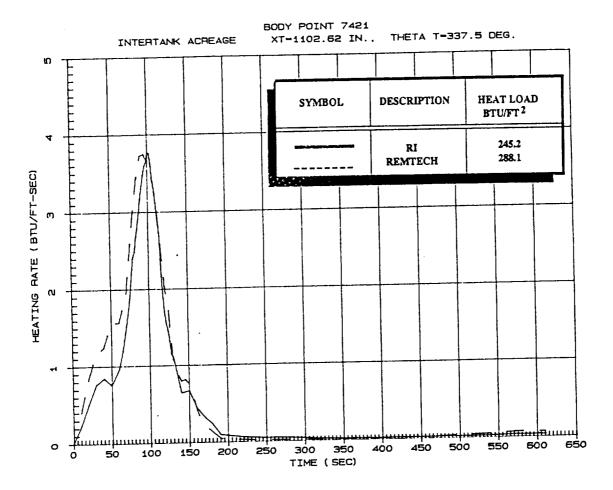


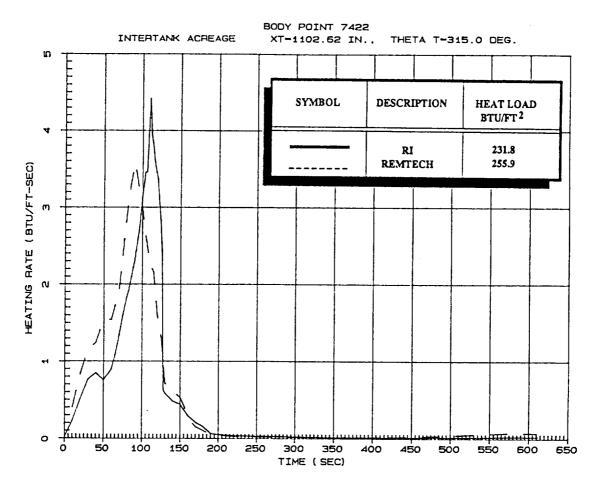


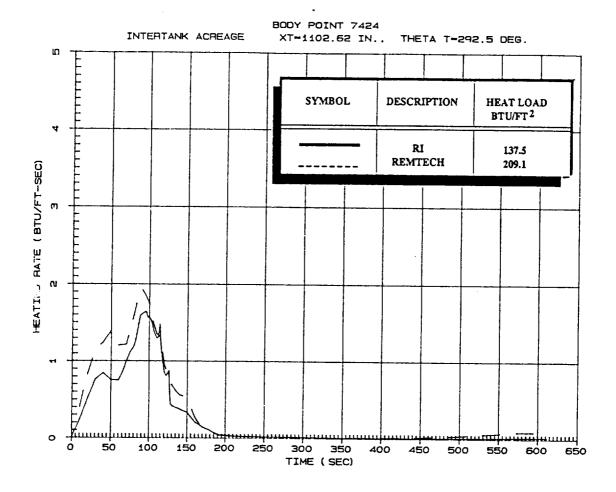


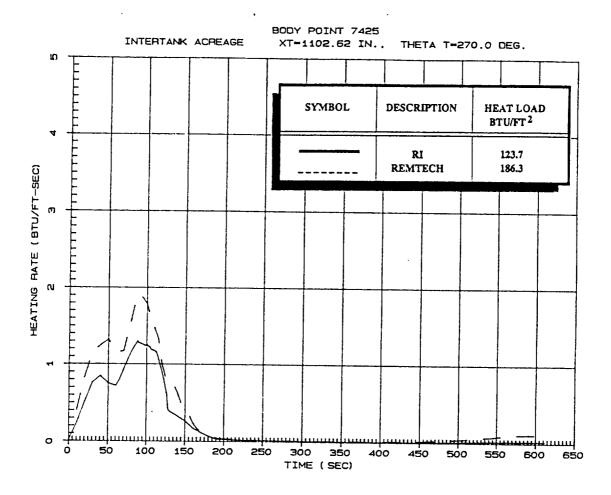


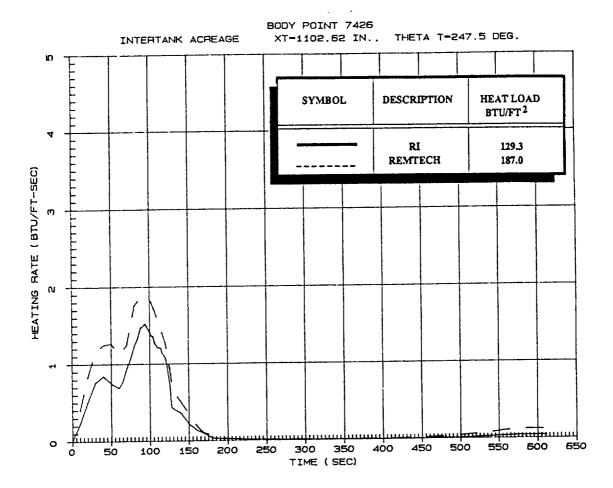


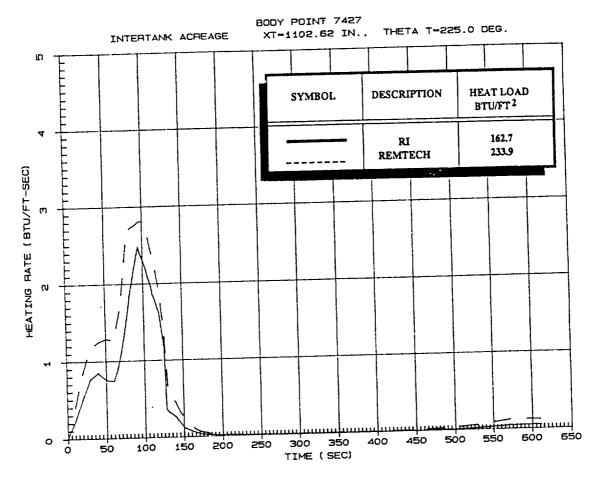


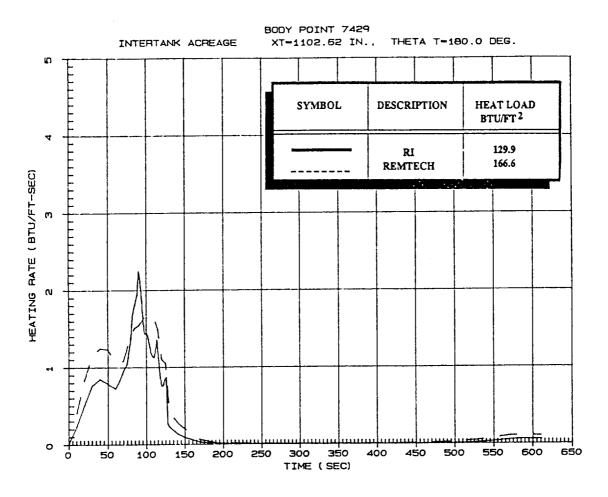


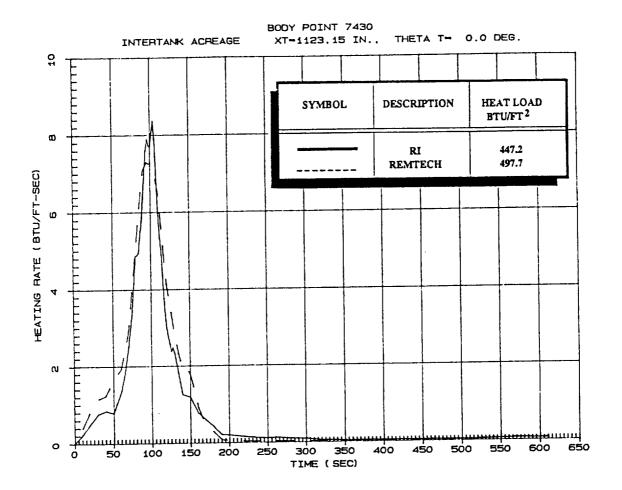


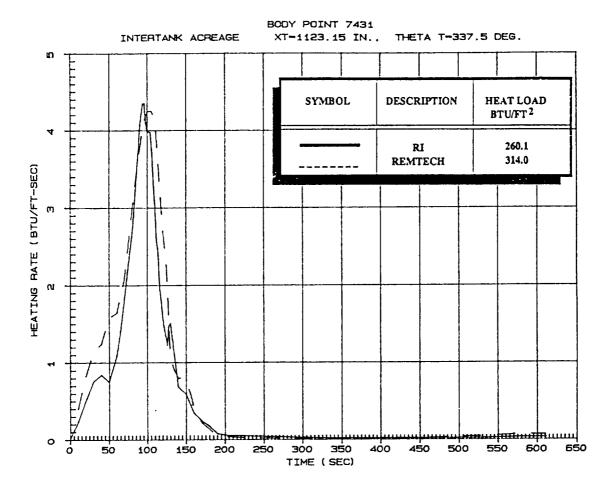


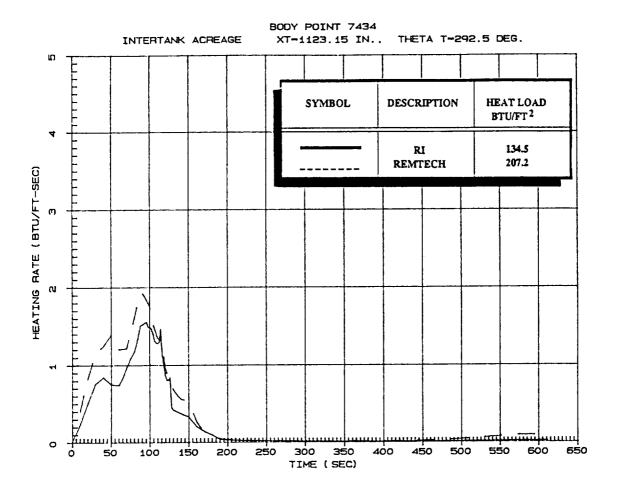


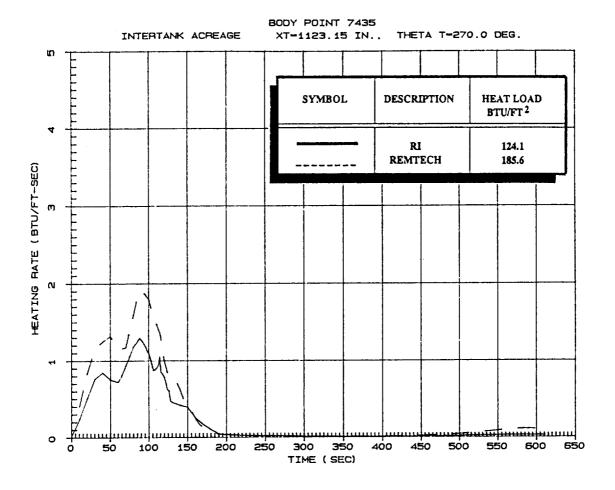


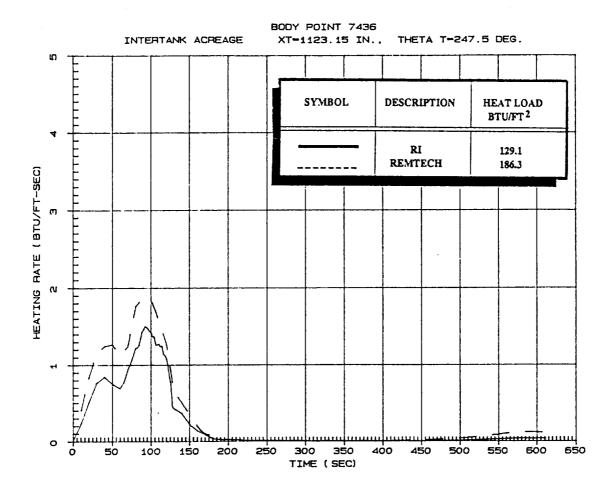


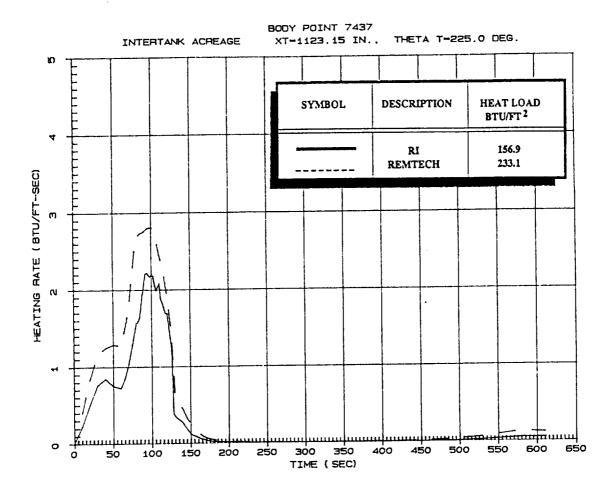


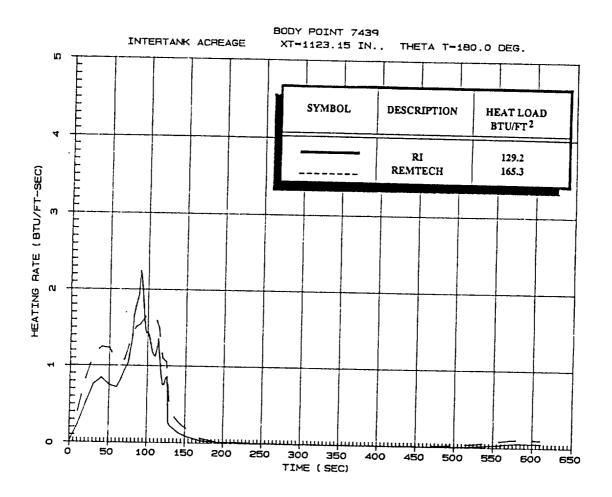


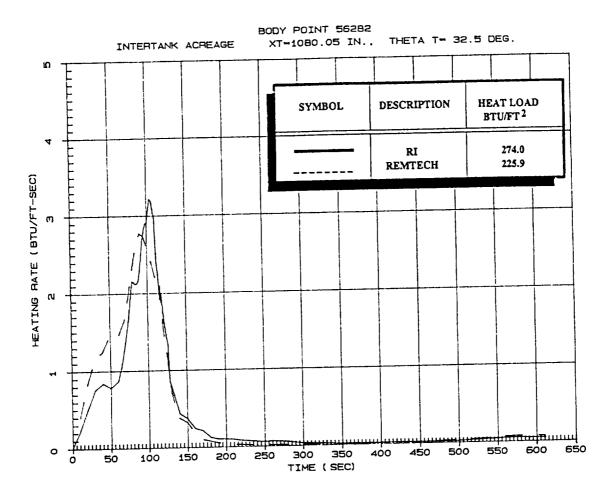




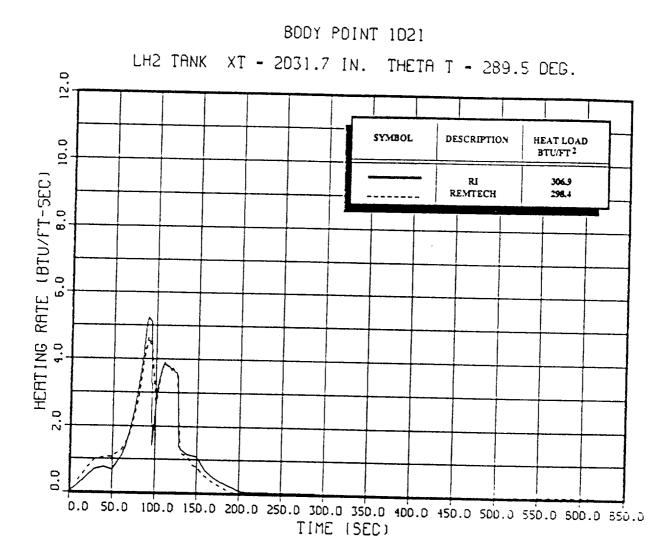




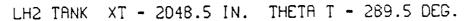


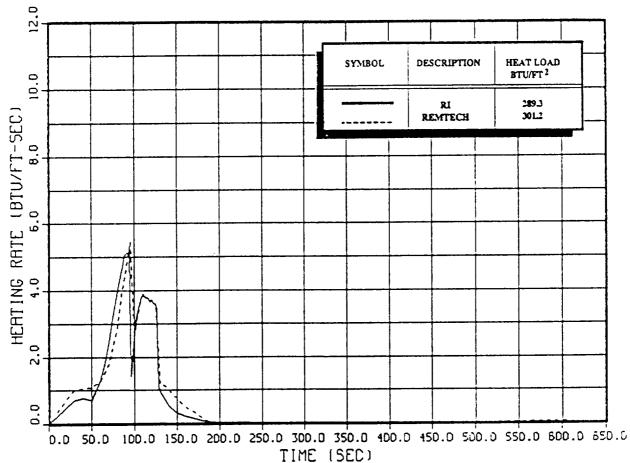


ASCENT DESIGN ENVIRONMENTS FOR THE ET LH<sub>2</sub> TANK ACREAGE BODY POINT LOCATIONS

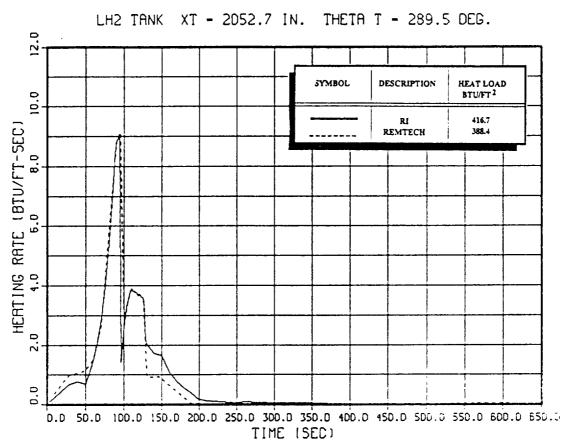


BDDY POINT 1023

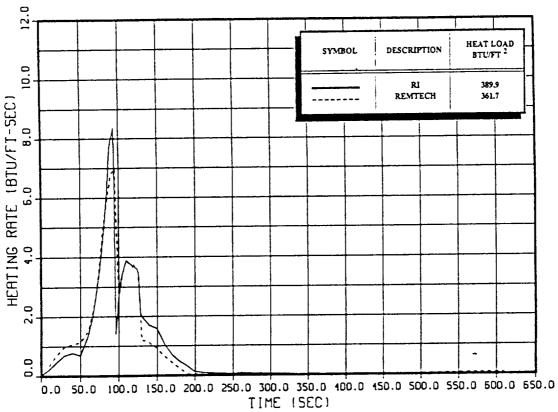




BODY POINT 1025

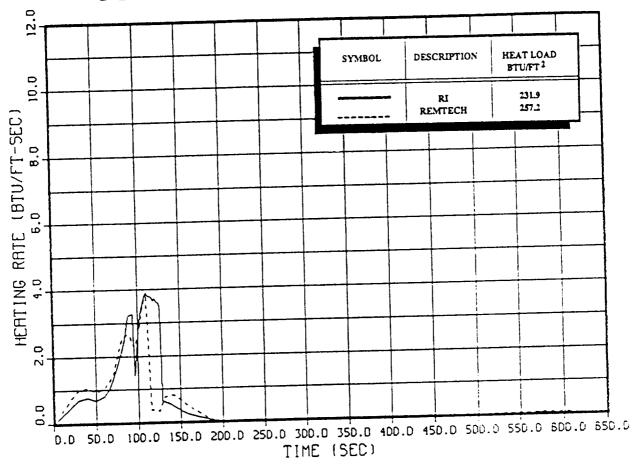


BODY POINT 1032 LH2 TANK XT - 2058.0 IN. THETA T - 283.9 DEG.

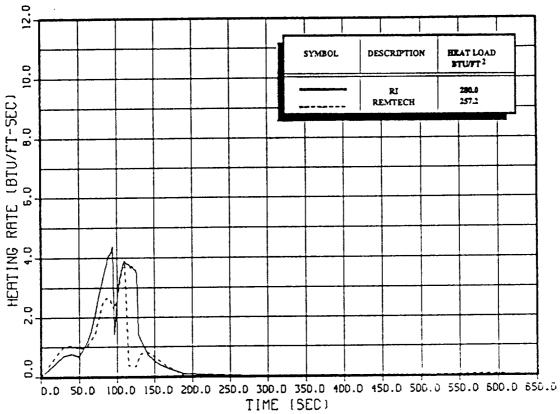


BODY POINT 1041

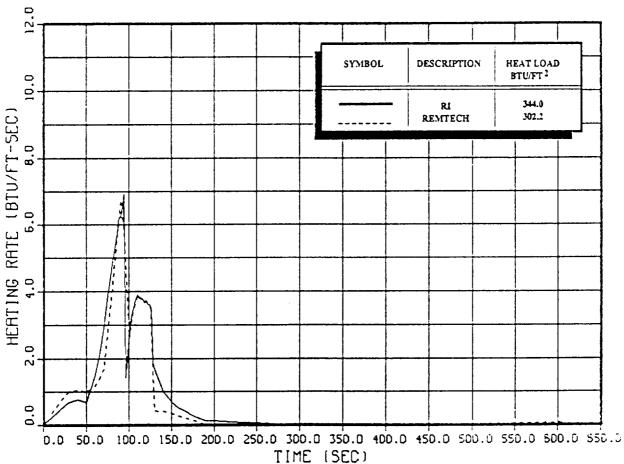
LH2 TANK XT - 2040.8 IN. THETA T - 250.5 DEG.



BODY POINT 1043 LH2 TANK XT - 2048.8 IN. THETA T - 250.5 DEG.

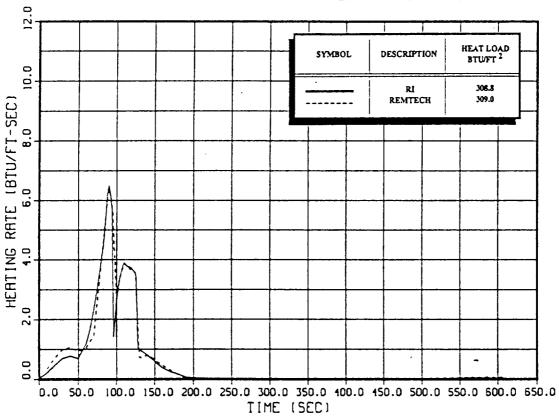


BODY POINT 1046 LH2 TANK XT - 2053.B IN. THETA T - 250.5 DEG.



BODY POINT 1054

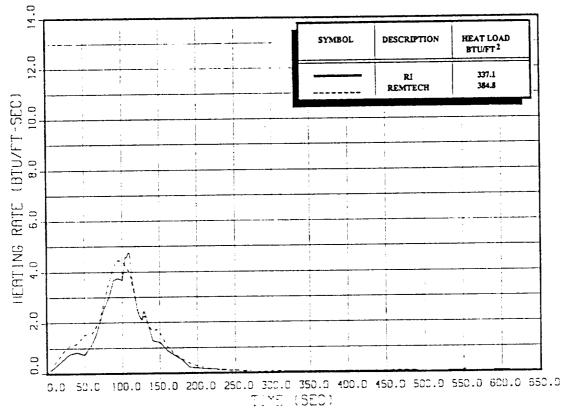
LH2 TANK XT - 2058.0 IN. THETA T - 247.0 DEG.



300Y POINT 1105 LH2 TANK XT = 1139.5 IN. THETA T = 343.0 DEG. 14.0 SYMBOL DESCRIPTION HEAT LOAD BTU/FT<sup>2</sup> 12.0 (BTU/FT-SEC) 8.0 10.0 RI REMTECH 37L1 361.1 HEMTING RATE 4.0 6.0 2.0 0.0 0.0 50.0 100.0 150.0 200.0 250.0 300.0 350.0 400.0 450.0 500.0 550.0 600.0 650.0

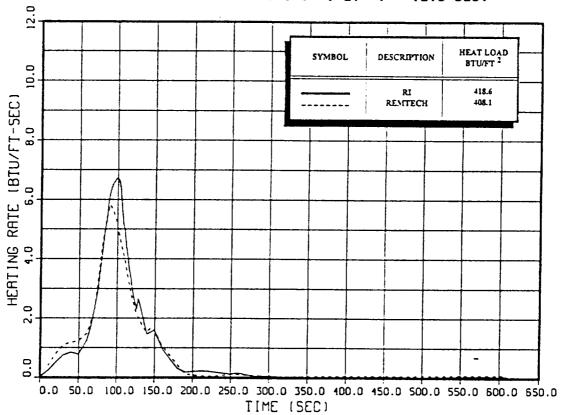
TIME (SEC)

BODY POINT 1110 LH2 TANK XT = 1139.5 IN. THETA T = 348.0 DEG.

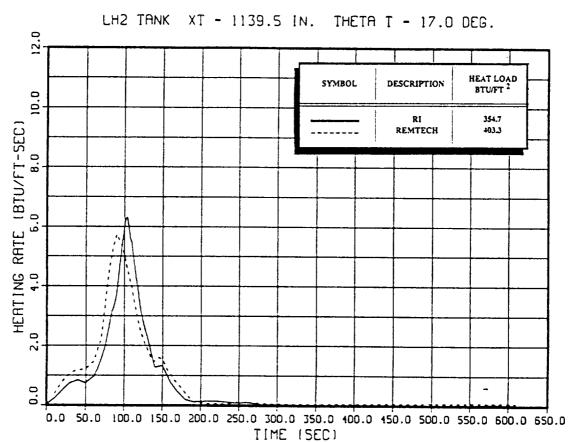


BODY POINT 1115

LH2 TANK XT - 1139.5 IN. THETA T - 12.0 DEG.

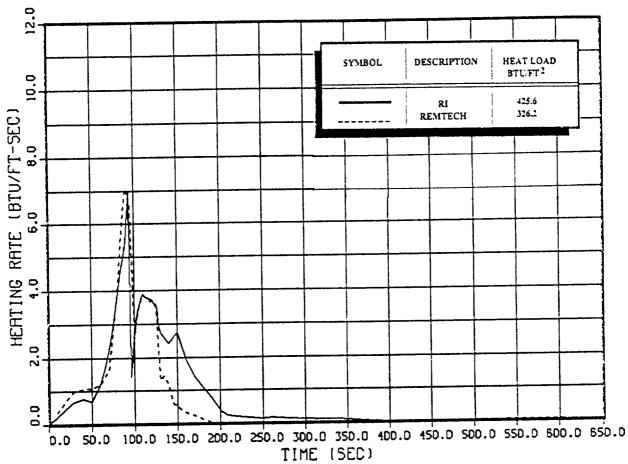


## BODY POINT 1122

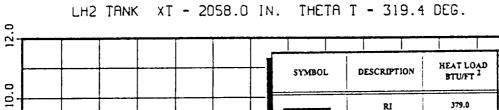


BODY POINT 1205

LH2 TANK XT - 2053.50 IN. THETA T - 312.6 DEG.



BODY POINT 1211

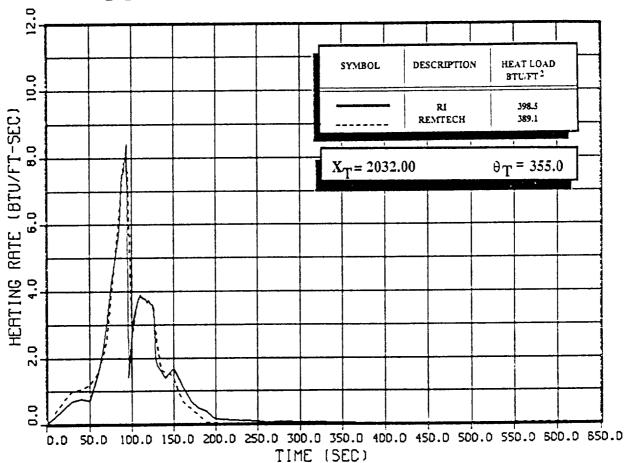


RI REMTECH

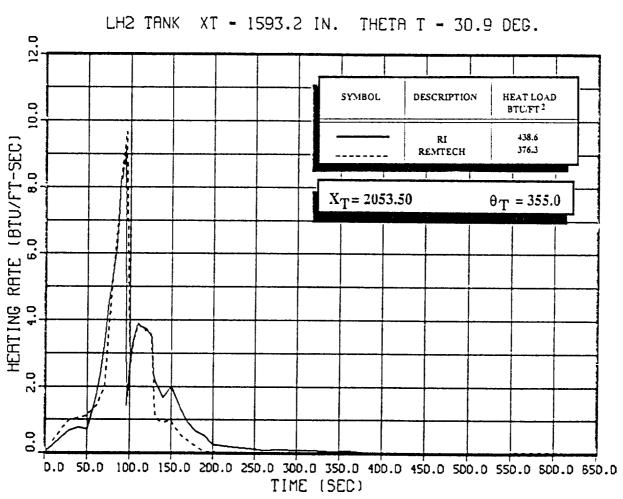
379.0 323.6

HERTING RATE (BTU/FT-SEC)
3 4.0 6.0 8.0 0.0 50.0 100.0 150.0 200.0 250.0 300.0 350.0 400.0 450.0 500.0 550.0 600.0 650.0 TIME (SEC)

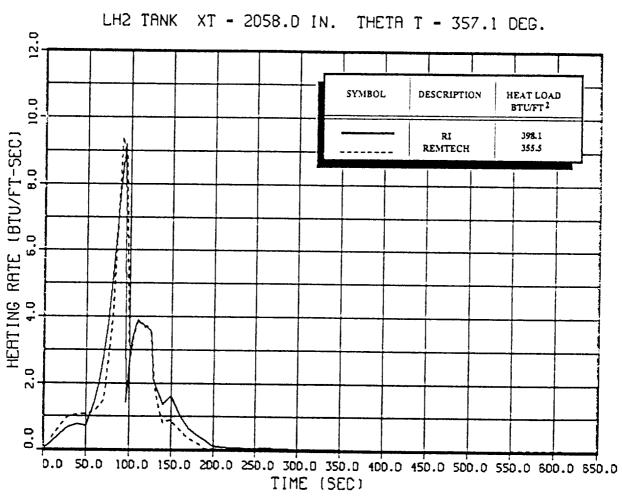
BODY POINT 1300 LH2 TANK XT - 1593.2 IN. THETA T - 30.9 DEG.



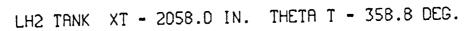


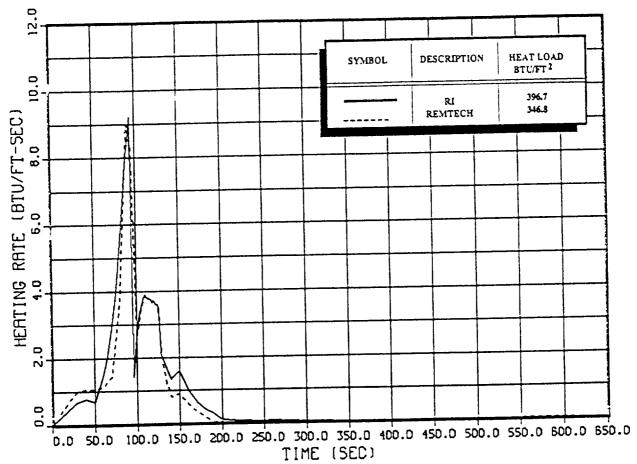


BDDY PDINT 1307

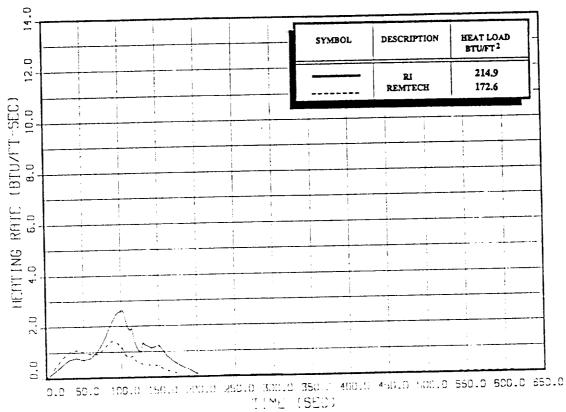


BODY POINT 1309



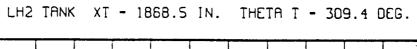


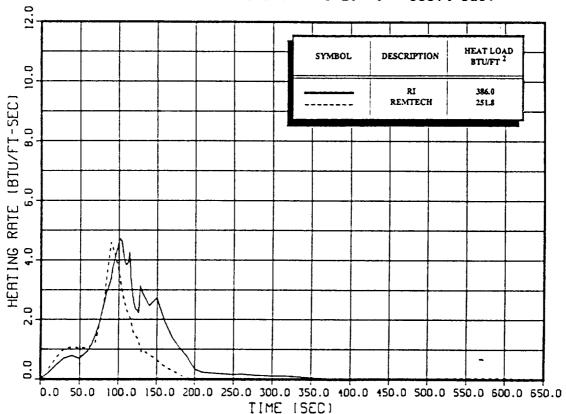
BODY POINT 1401 LH2 TANK XT = 1822.4 IN. THETA T = 309.4 DEG.

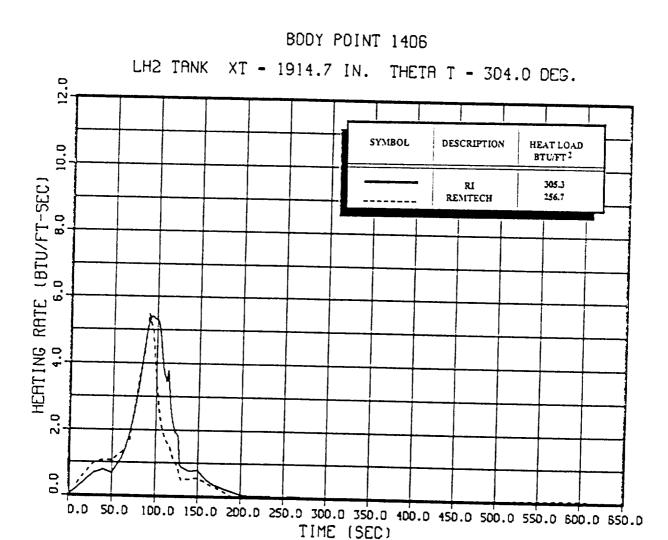


•RI IVBC-3 considered high from a consistency standpoint with surrounding environments. Hi/Hu factors are high compared with the IH-97 data base (T/C 5252).

BODY POINT 1404







BODY PDINT 1409

LH2 TANK XT - 1914.7 IN. THETA T - 315.0 DEG.

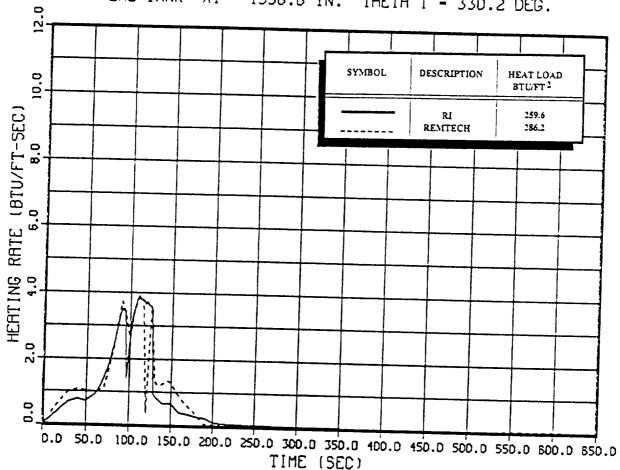
SYMBOL DESCRIPTION HEATLOAD STUFF?

RI :63.5
246.7

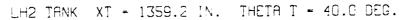
REMITECH :246.7

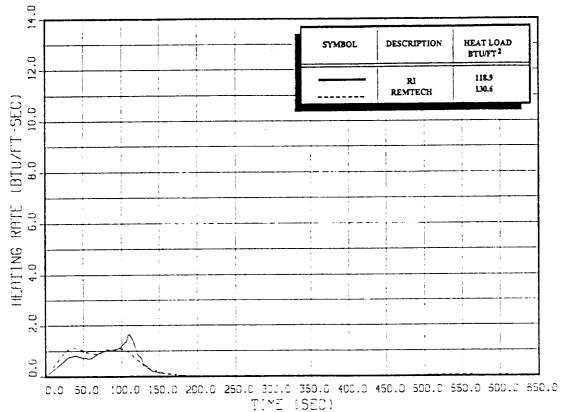
TIME (SEC)

BDDY PDINT 1414 LH2 TANK XT - 1936.8 IN. THETA T - 330.2 DEG.

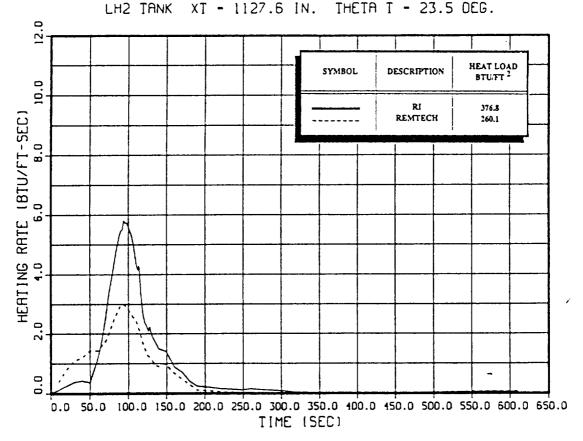


BODY POINT 6555





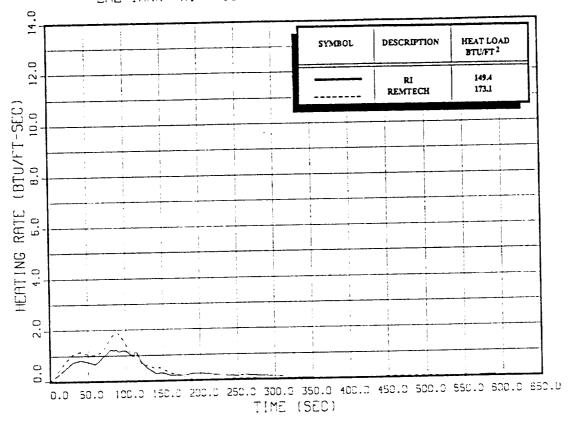
BODY POINT 6582



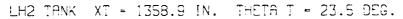
 $\bullet$  RI IVBC-3 environments considered high. B.P. 6582 is located under the LO<sub>2</sub> feed line. Max rates at other similar locations range from 1 to 3 BTU/FT <sup>2</sup> sec.

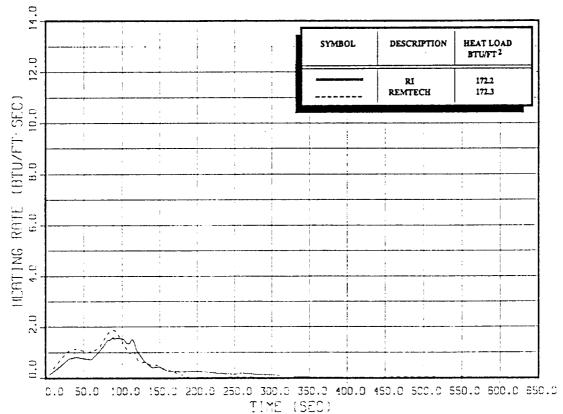
BODY POINT 6587

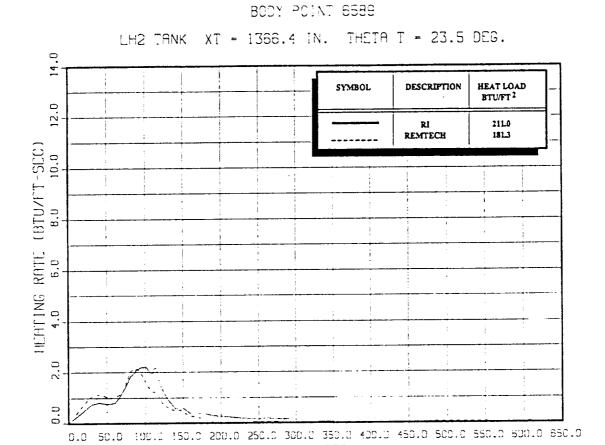
LH2 TANK XT = 1334.4 IN. THETA T = 23.5 DEG.



BODY POINT 8588



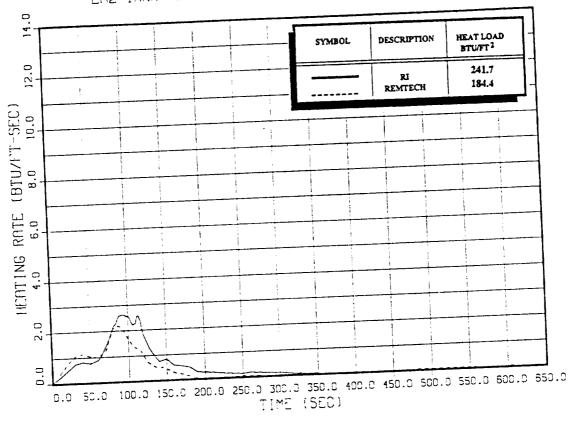




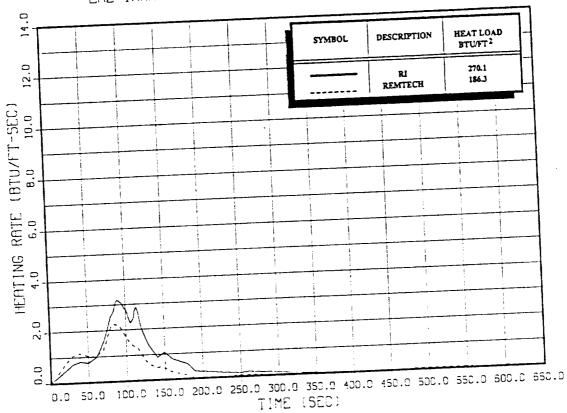
TIME (SEC)

Agreement is acceptable; no TPS impact.

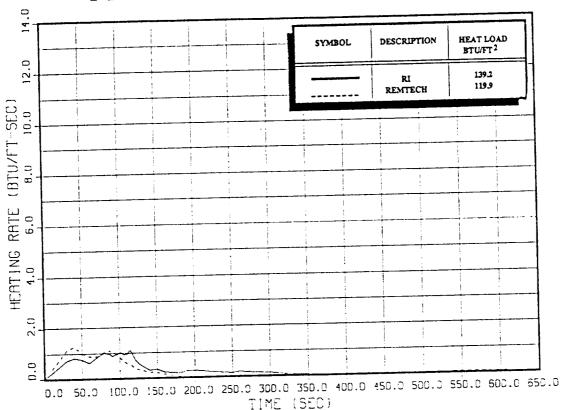
BODY POINT 6590 LH2 TANK XT = 1372.0 IN. THETA T = 23.5 DEG.



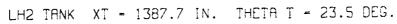
BODY POINT 6593 LH2 TANK XT = 1375.3 IN. THETA T = 23.5 DEG.

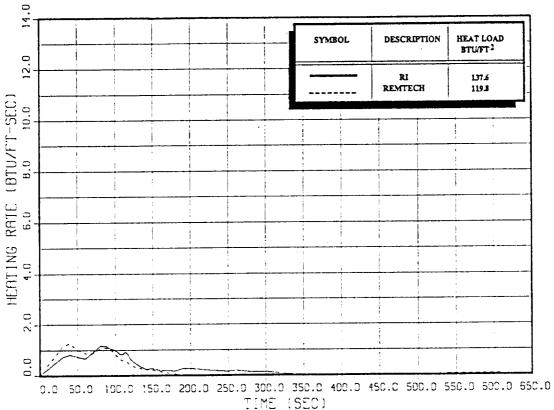


BODY POINT 6594 LH2 TANK XT - 1380.4 IN. THETA T = 23.5 DEG.



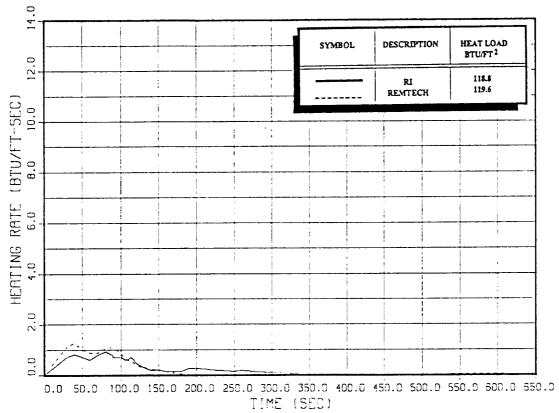
BODY POINT 6596



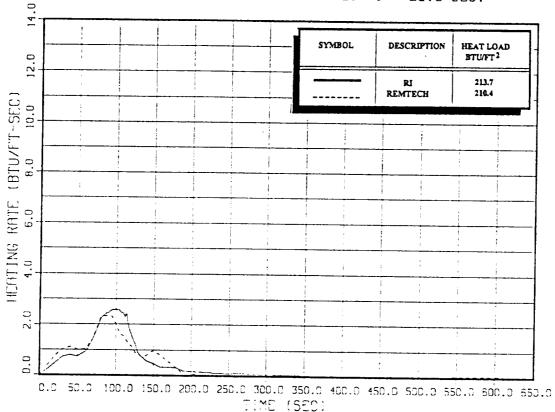


BODY POINT 6597

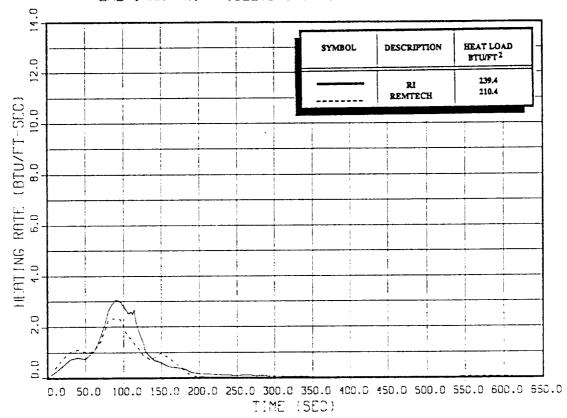
LH2 TANK XT = 1401.0 IN. THETA T = 23.5 DEG.



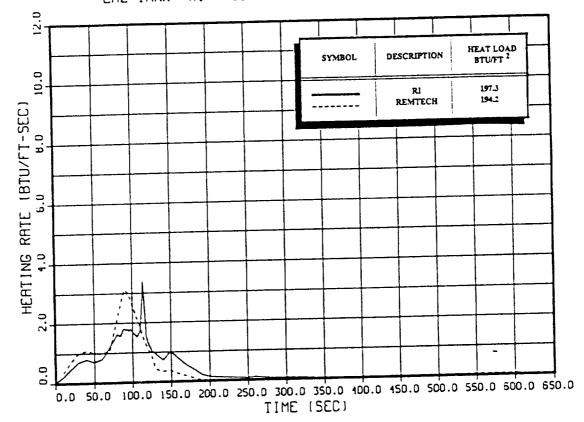
BODY POINT 6603 LH2 TANK XT = 1618.7 IN. THETA T = 23.5 DEG.



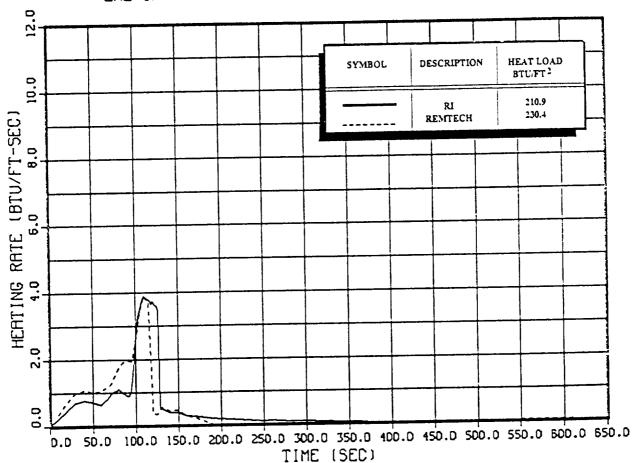
BODY POINT 6606 LH2 TANK XT = 1622.0 IN. THETA T = 23.5 DEG.



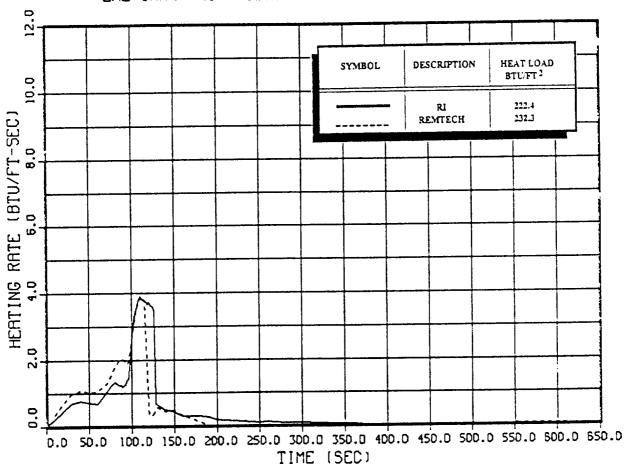
BODY POINT 6617 LH2 TANK XT - 1868.7 IN. THETA T - 23.5 DEG.



BODY POINT 6632 LH2 TANK XT - 1955.3 IN. THETA T - 23.5 DEG.



BODY POINT 6633 LH2 TANK XT - 1962.B IN. THETA T - 23.5 DEG.



BODY POINT 6634

LH2 TANK XT - 1968.4 IN. THETA T - 23.5 DEG.

SYMBOL DESCRIPTION HEAT LOAD BTUFT?

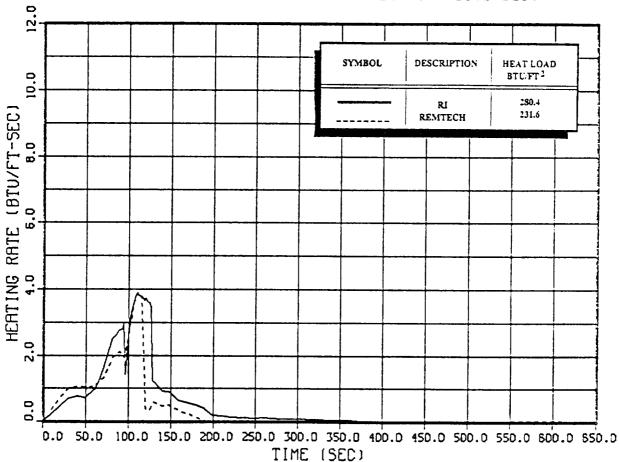
RI MILI 233.7

REMITECH 233.7

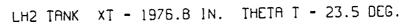
0.0 50.0 100.0 150.0 200.0 250.0 300.0 350.0 400.0 450.0 500.0 550.0 600.0 650.0 TIME (SEC)

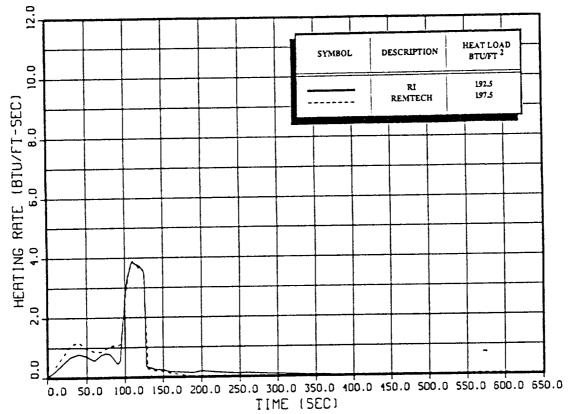
BODY POINT 6637

LH2 TANK XT - 1971.7 IN. THETA T - 23.5 DEG.



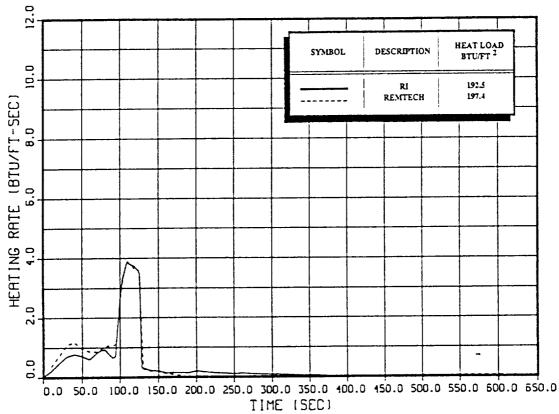
BODY POINT 6638



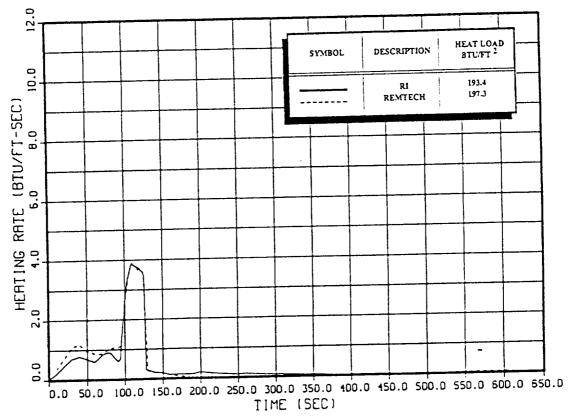


BODY POINT 6639

LH2 TANK XT - 1980.3 IN. THETA T - 23.5 DEG.

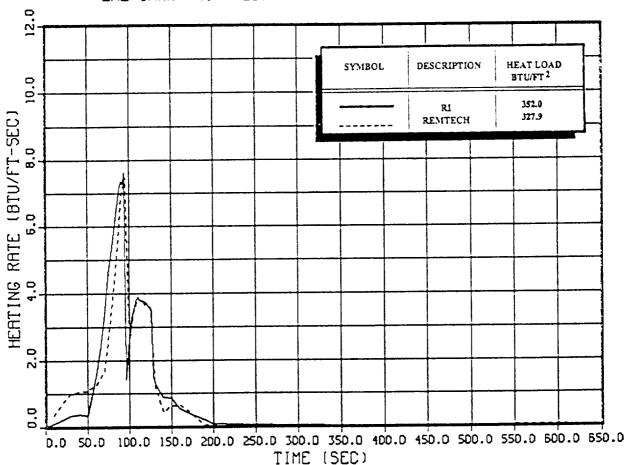


BODY POINT 6640 LH2 TANK XT - 1984.1 IN. THETA T - 23.5 DEG.

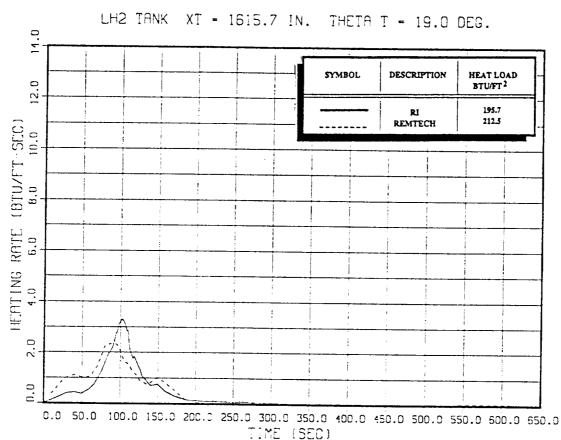


BODY PDINT 6647

LH2 TANK XT - 2033.0 IN. THETA T - 23.5 DEG.

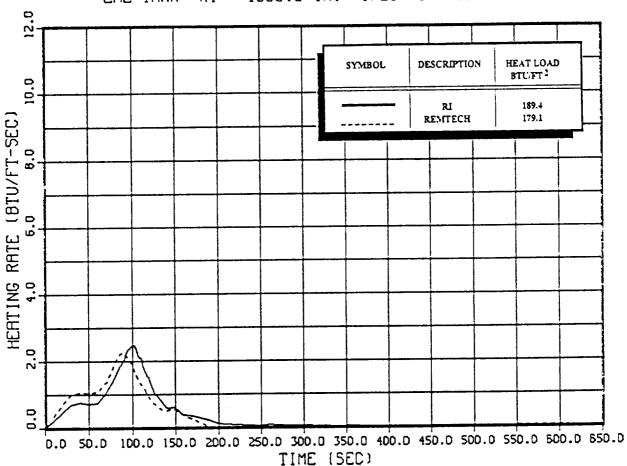


BODY POINT 6699



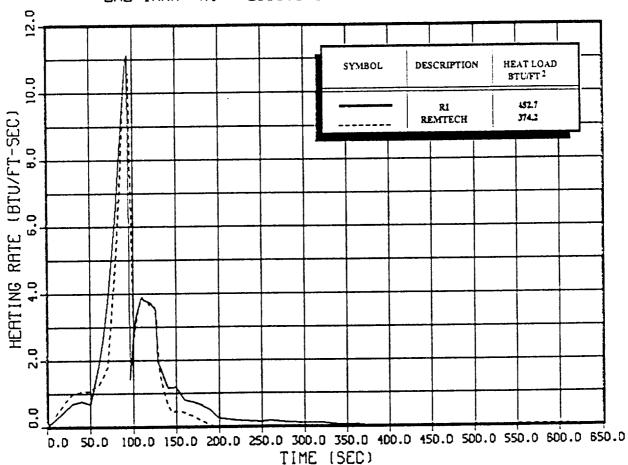
BODY POINT 6909

LH2 TANK XT - 1999.5 IN. THETA T - 19.0 DEG.

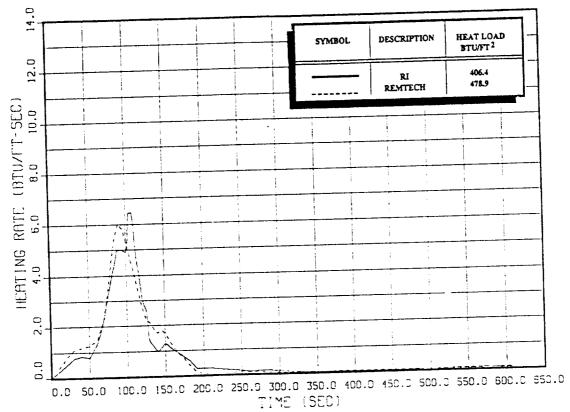


BODY POINT 6929

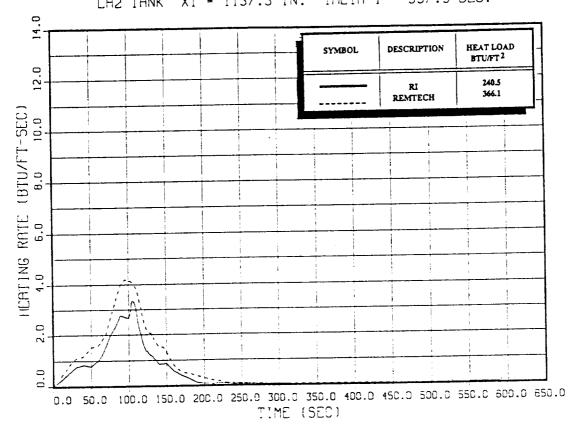
LH2 TANK XT - 2036.5 IN. THETA T - 19.0 DEG.



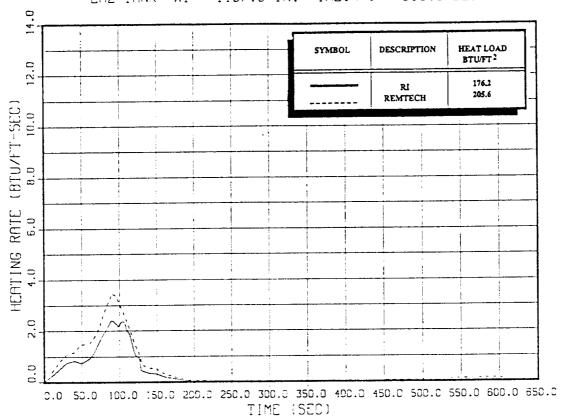
BODY POINT 7440 LH2 TANK XT = 1137.3 IN. THETA T = 0.0 DEG.



BODY POINT 7441 LH2 TANK XT = 1137.3 IN. THETA T = 337.5 DEG.

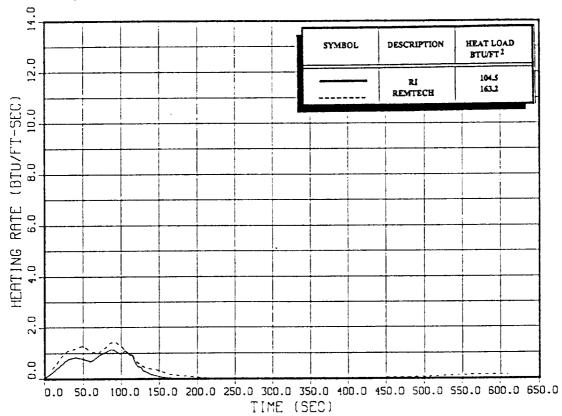


BODY PCINT 7442 LH2 TANK XT = 1137.3 IN. THETA T = 315.0 DEG.



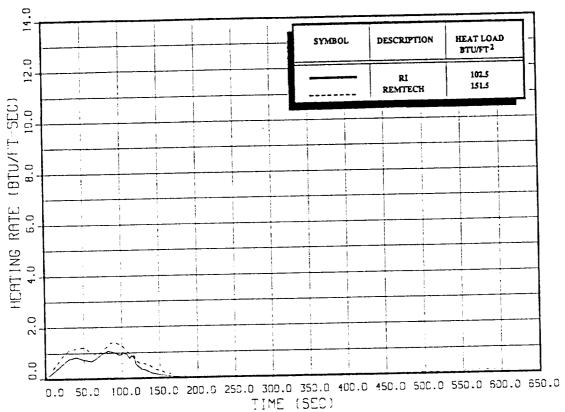
BODY POINT 7444

LH2 TANK XT = 1137.3 IN. THETA T = 292.5 DEG.

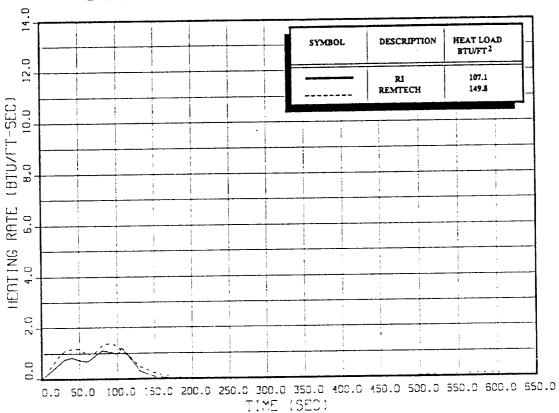


BODY PCINT 7445

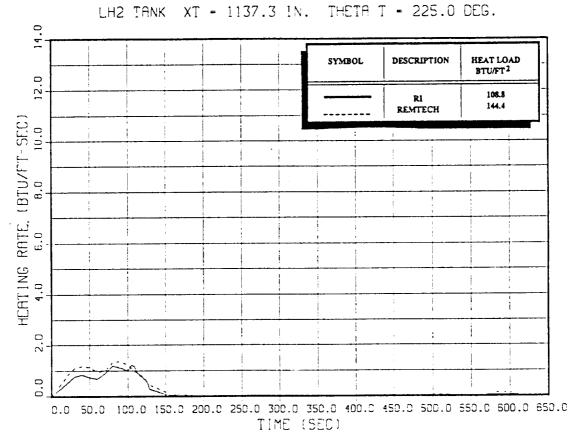
LH2 TANK XT = 1137.3 IN. THETA T = 270.0 DEG.



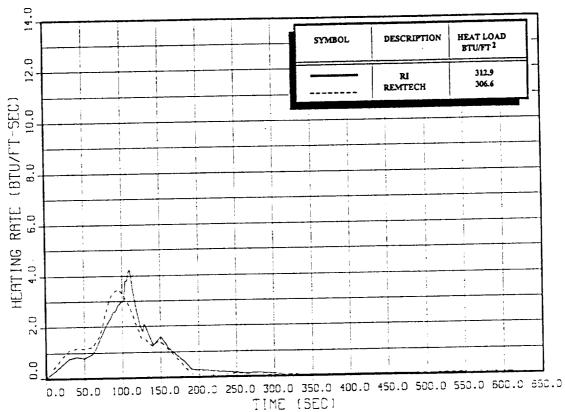
BODY POINT 7446 LH2 TANK XT = 1137.3 IN. THETA T = 247.5 DEG.



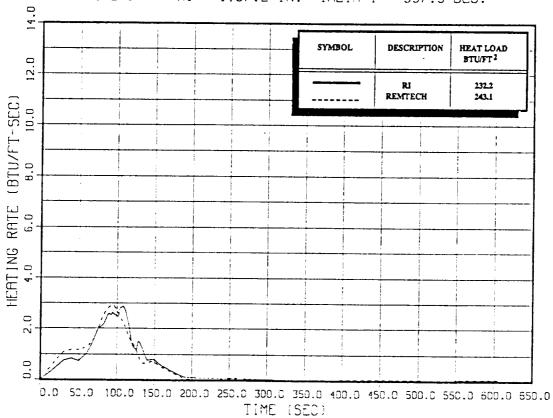
BODY POINT 7447



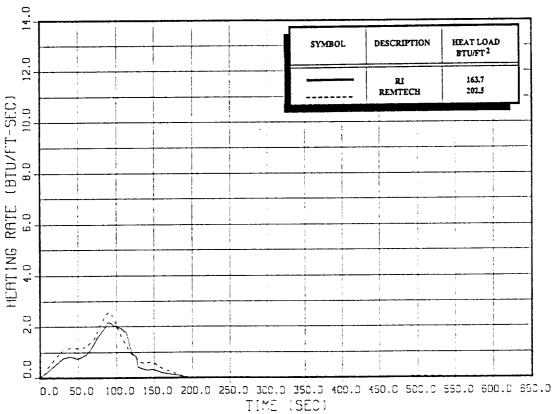
BODY POINT 7450 LH2 TANK XT = 1167.2 IN. THETA T = 0.0 DEG.



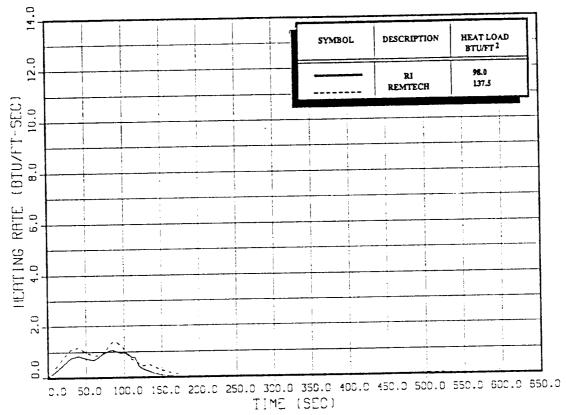
BODY POINT 745: LH2 TANK XT = 1167.2 IN. THETA T = 337.5 DEG.

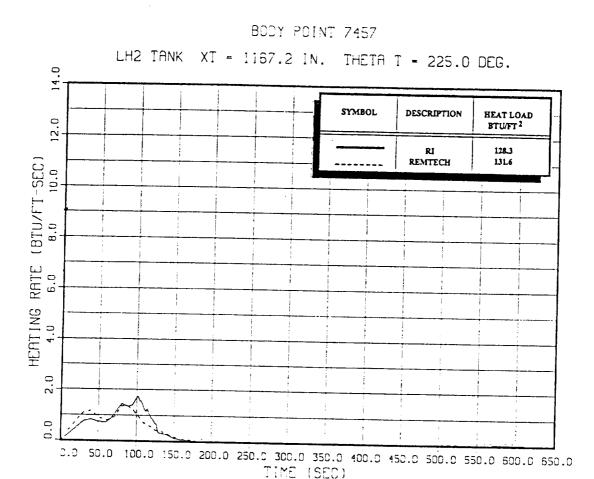


BODY POINT 7452 LH2 TANK XT = 1167.2 IN. THETA T = 315.0 DEG.

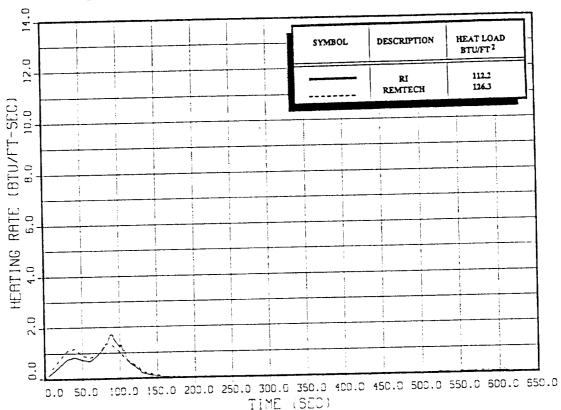


BODY POINT 7455 LH2 TANK XT = 1167.2 IN. THETA T = 270.0 DEG.

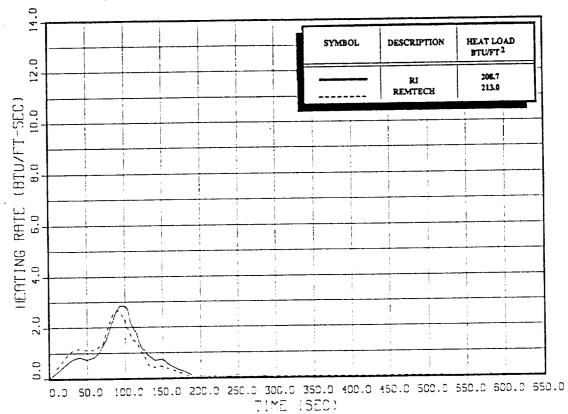




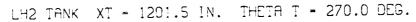
BODY POINT 7459 LH2 TANK XT = 1167.2 IN. THETA T = 180.0 DEG.

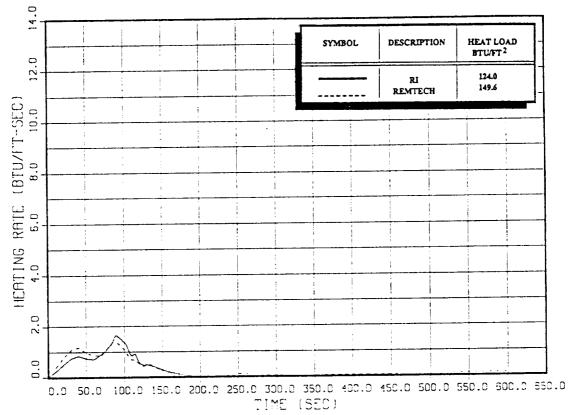


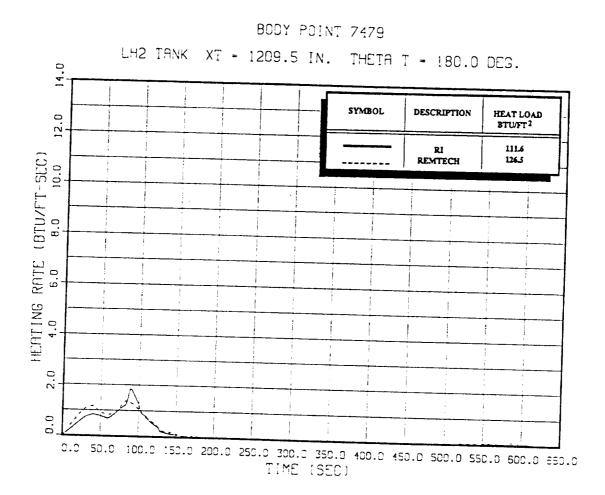
BODY POINT 7470 LH2 TANK XT = 1201.5 IN. THETA T = 0.0 DEG.



BODY POINT 7475

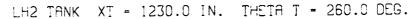


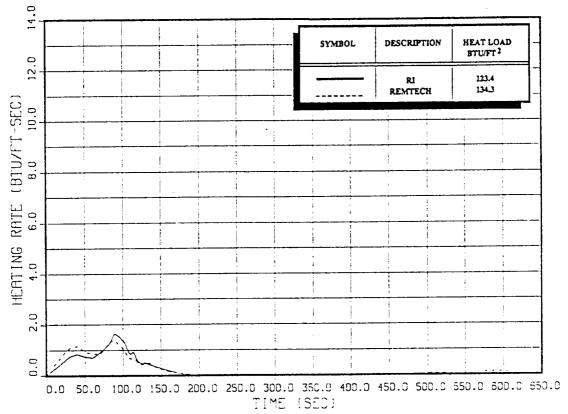




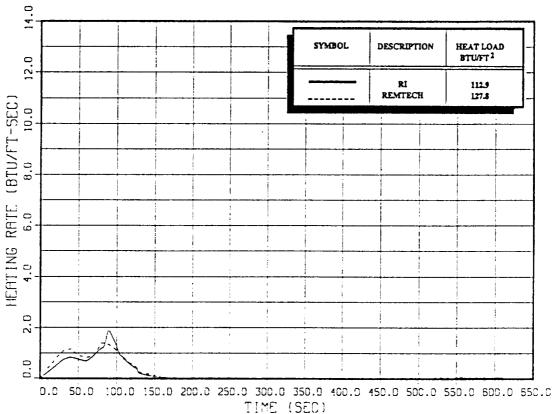
Agreement is acceptable; no TPS impact.

BODY POINT 7485

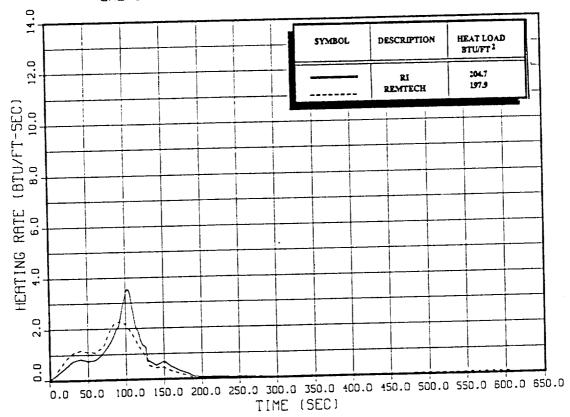




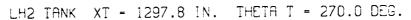
BODY POINT 7489 LH2 TANK XT - 1230.0 IN. THETA T - 180.0 DEG.

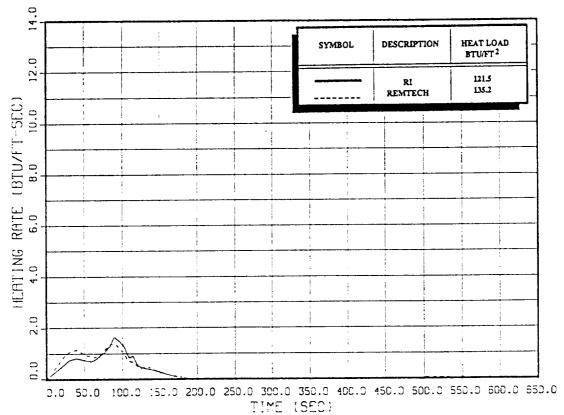


BCDY POINT 7520 LH2 TANK XT = 1297.8 [N. THETA T = 0.0 DEG.



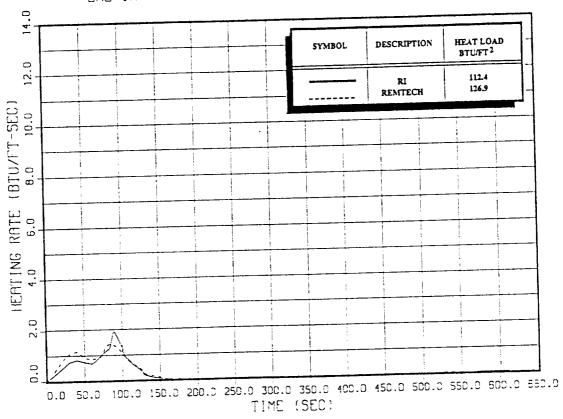
BODY POINT 7525





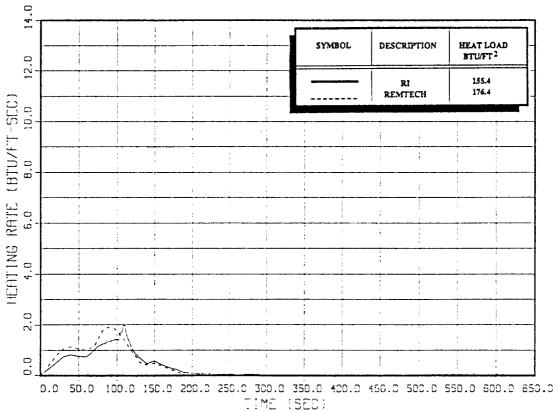
BODY POINT 7529

LH2 TANK XT = 1297.8 IN. THETA T = 180.0 DEG.



BODY POINT 7550





BOOY POINT 755!

LH2 TANK XT = 1359.2 IN. THETA T = 337.5 DEG.

SYMBOL DESCRIPTION HEAT LOAD BY UST 2

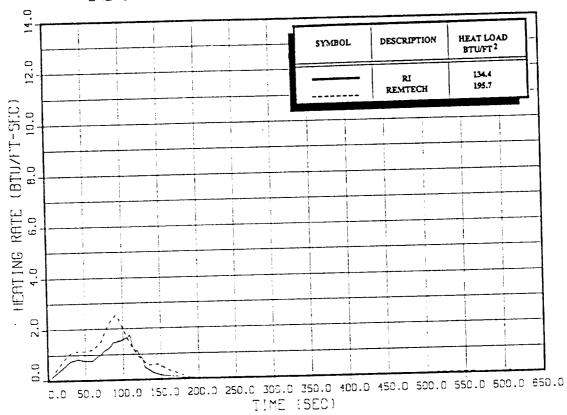
RI 137.4 REMTECH 170.5

0.0 50.0 100.0 150.0 200.0 250.0 300.0 350.0 400.0 450.0 500.0 550.0 600.0 650.0

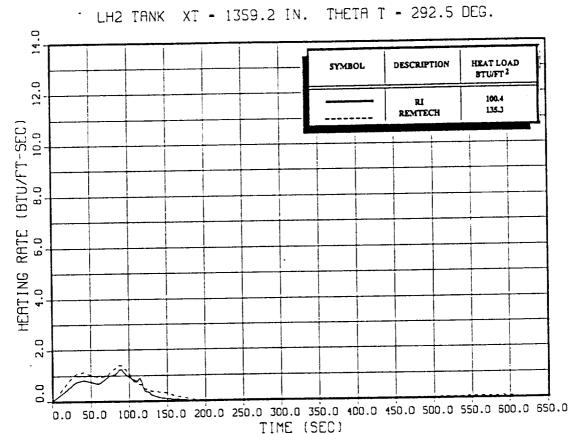
TIME (SEC)

Agreement is acceptable; no TPS impact.

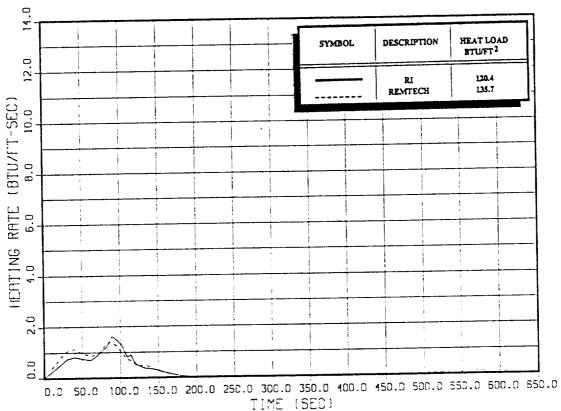
BODY POINT 7552 LH2 TANK XT = 1359.2 IN. THETA T = 315.0 DEG.



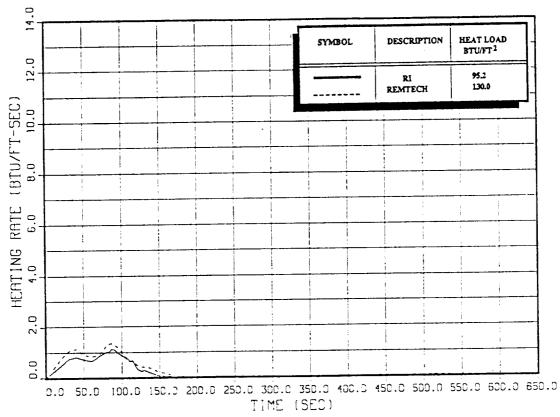
BODY POINT 7554



BODY POINT 7555 LH2 TANK XT = 1359.2 IN. THETA T = 270.0 DEG.

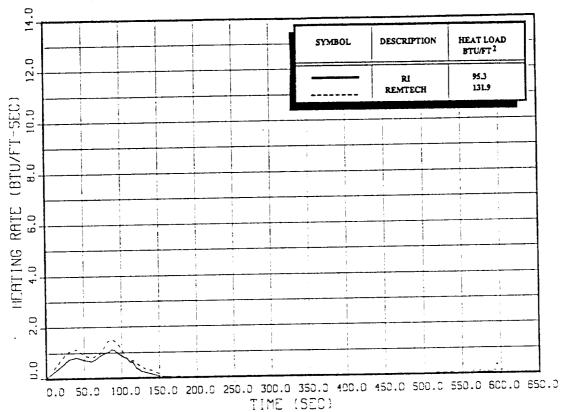


BODY POINT 7556 LH2 TANK XT = 1359.2 IN. THETA T = 247.5 DEG.

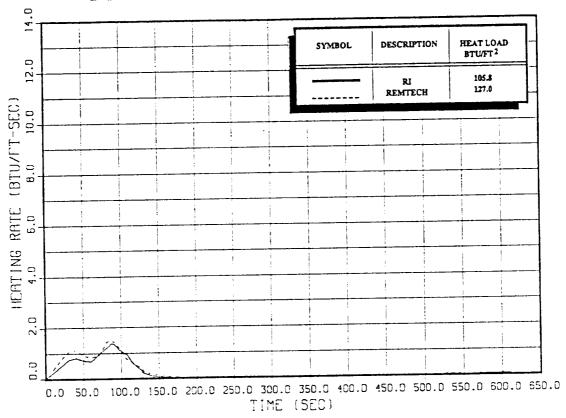


BODY POINT 7557

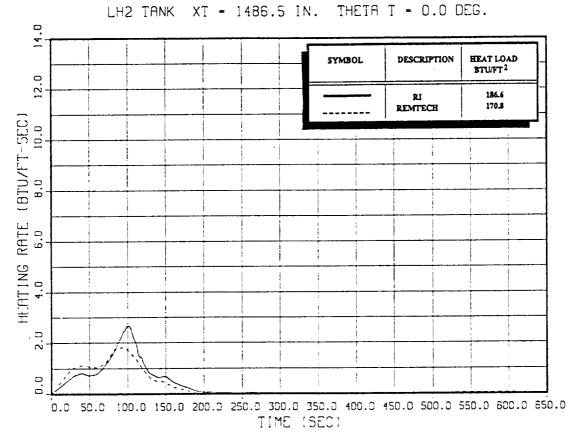
LH2 TANK XT = 1359.2 IN. THETA T = 225.0 DEG.



BODY POINT 7559 LH2 TANK XT = 1359.2 IN. THETA T = 180.0 DEG.

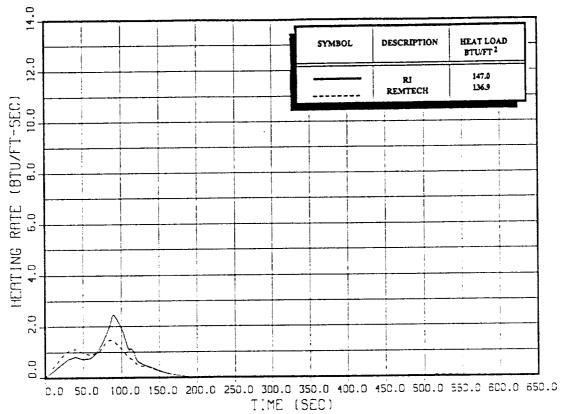


BODY PCINT 7620



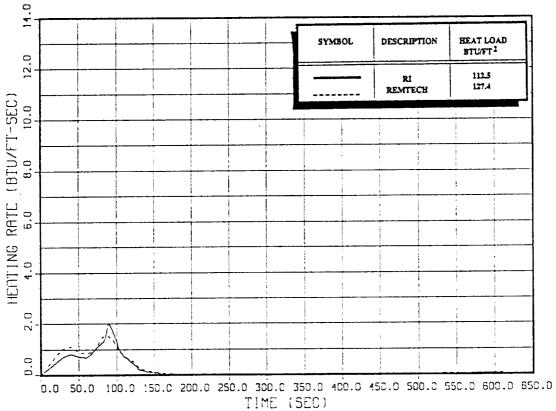
BODY POINT 7625

LH2 TANK XT = 1486.5 IN. THETA T = 270.0 DEG.

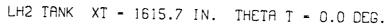


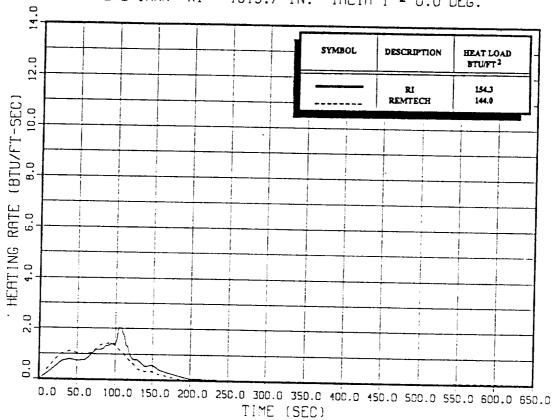
BODY POINT 7629

LH2 TANK XT = 1486.5 IN. THETA T = 180.0 DEG.



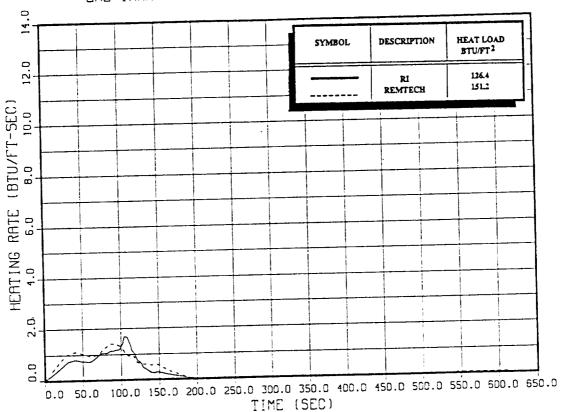
BODY POINT 7690



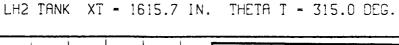


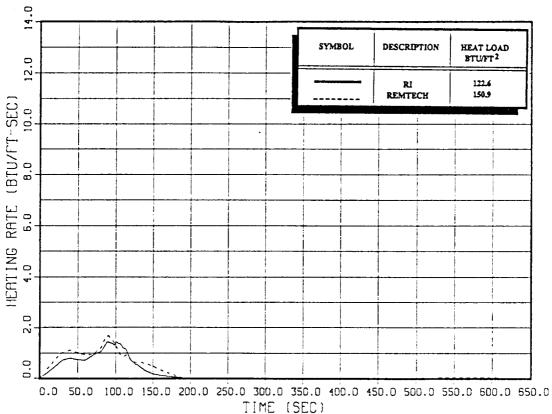
BODY POINT 7691

LH2 TANK XT - 1615.7 IN. THETA T - 337.5 DEG.

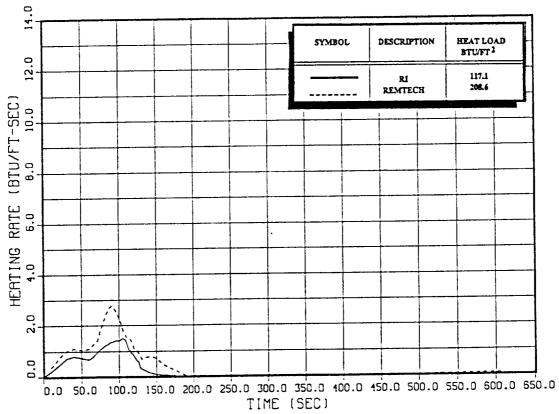


BODY POINT 7692

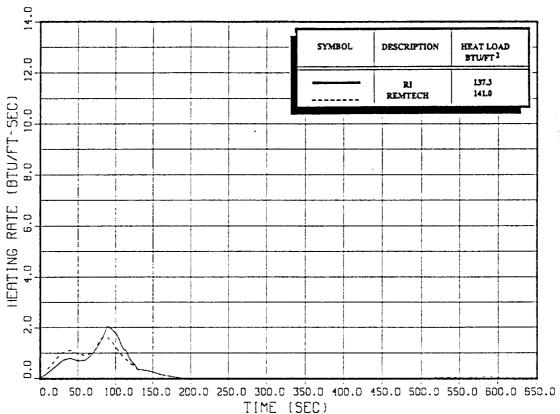




BODY POINT 7694 LH2 TANK XT = 1615.7 IN. THETA T = 292.5 DEG.

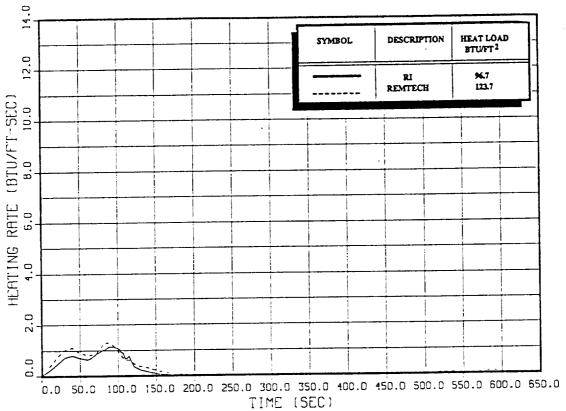


BODY POINT 7695 LH2 TANK XT = 1615.7 IN. THETA T = 270.0 DEG.



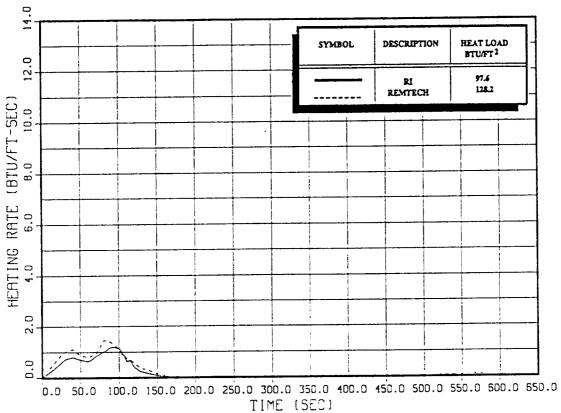
BODY POINT 7696

LH2 TANK XT = 1615.7 IN. THETA T = 247.5 DEG.



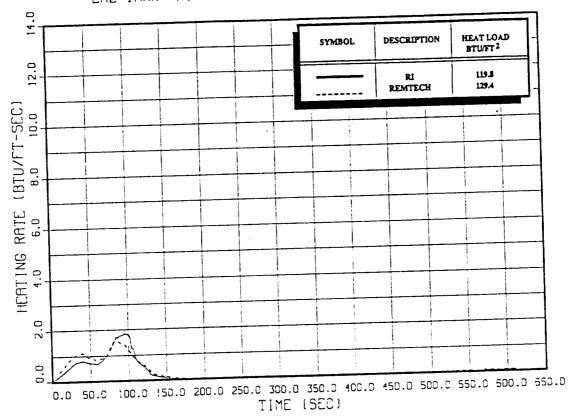
BODY POINT 7697

LH2 TANK XT = 1615.7 IN. THETA T = 225.0 DEG.

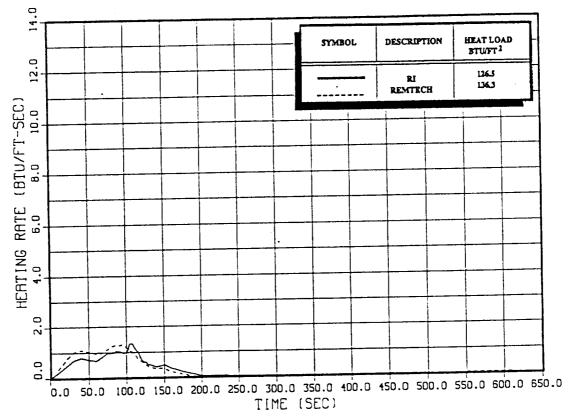


BODY POINT 7699

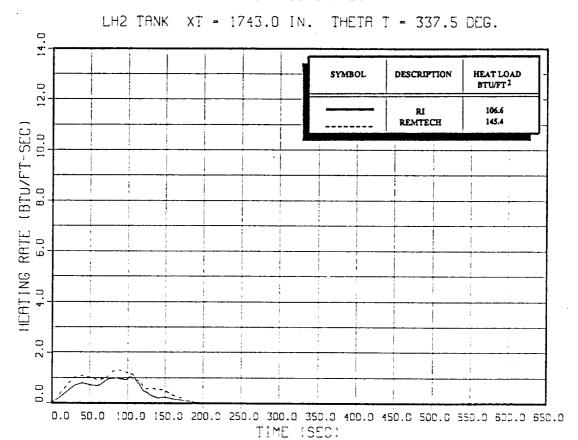
LH2 TANK XT - 1615.7 IN. THETA T - 180.0 DEG.



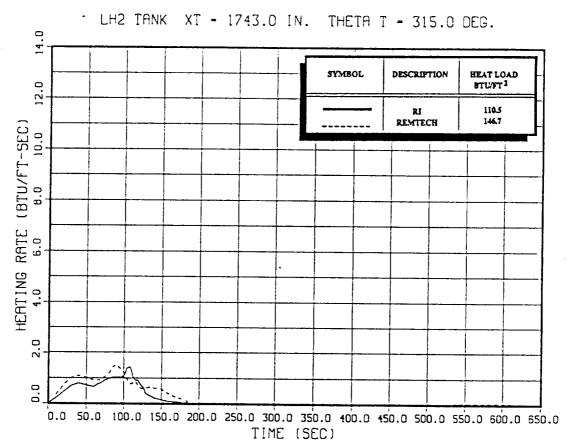
BODY POINT 7760 LH2 TANK XT = 1743.0 IN. THETA T = 0.0 DEG.



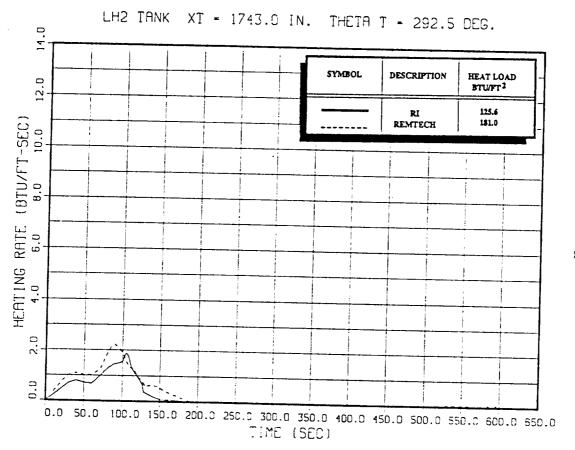
BODY POINT 7761



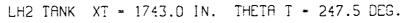
BODY POINT 7762

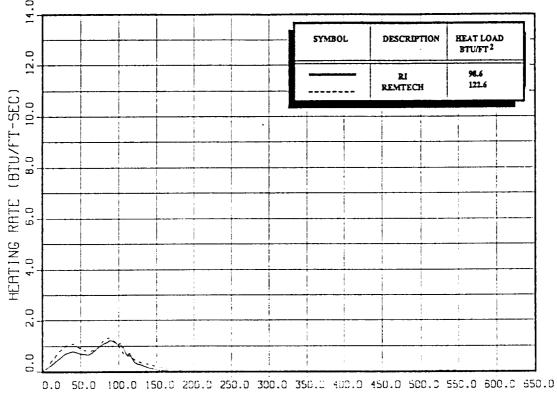


BCDY POINT 7764



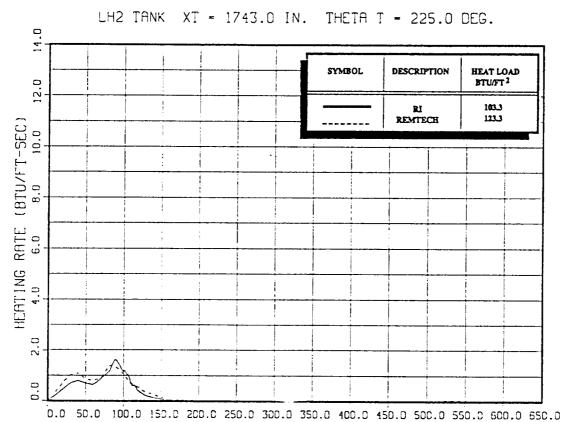
BODY POINT 7766





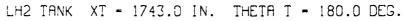
0.0 50.0 100.0 150.0 200.0 250.0 300.0 350.0 400.0 450.0 500.0 550.0 600.0 650.0 TIME (SEC)

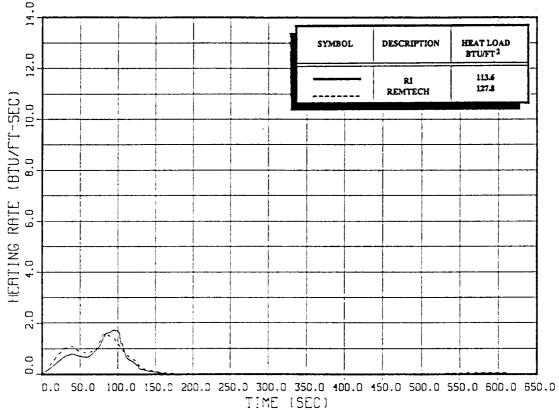
BODY POINT 7767



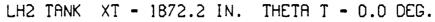
TIME (SEC)

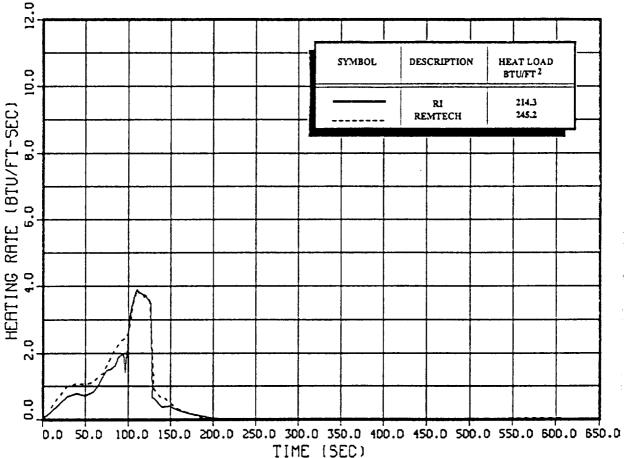
BODY POINT 7759



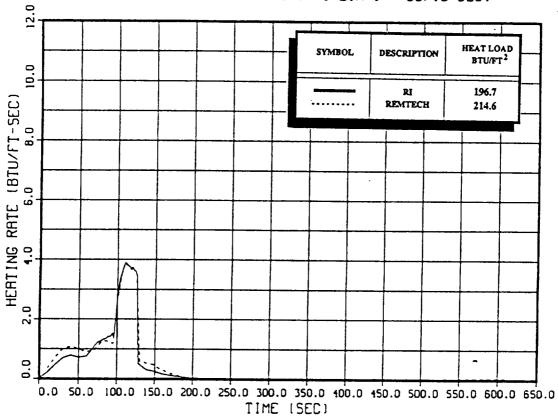


BDDY POINT 7830

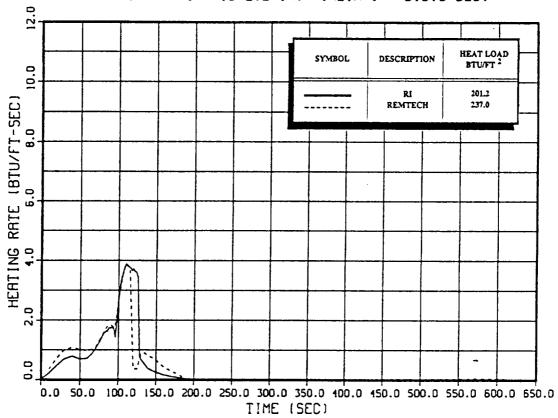




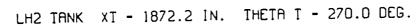
BODY POINT 7831 LH2 TANK XT - 1872.2 IN. THETA T - 337.5 DEG.

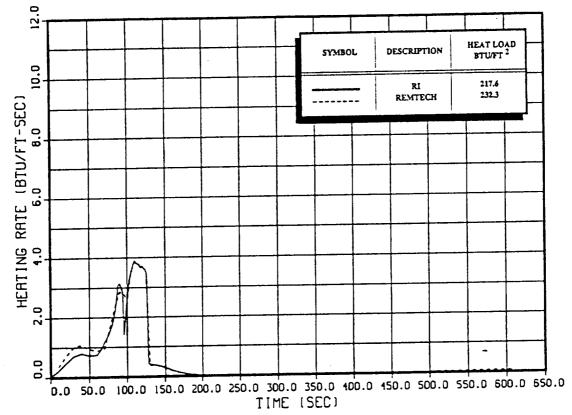


BODY POINT 7832 LH2 TANK XT - 1872.2 IN. THETA T - 315.0 DEG.

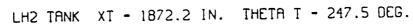


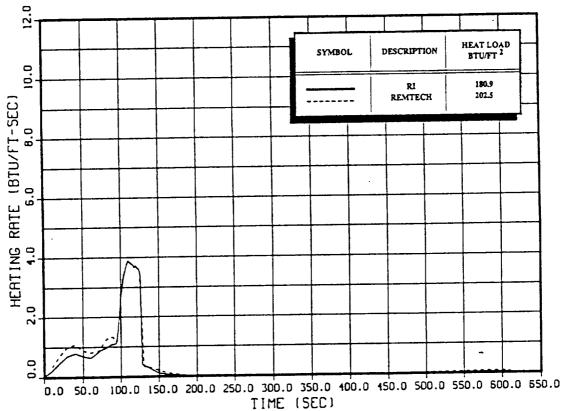
BODY POINT 7835



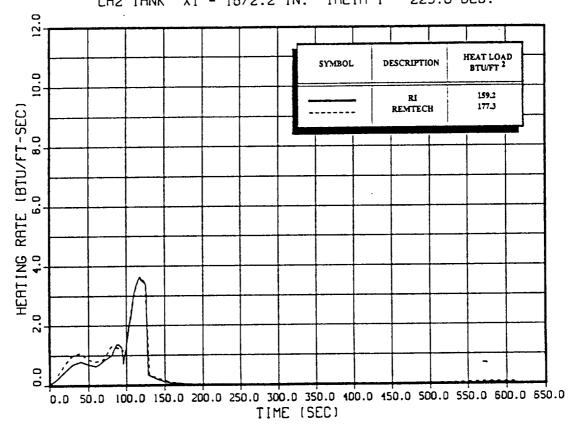


BODY POINT 7836

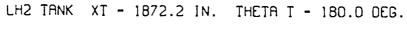


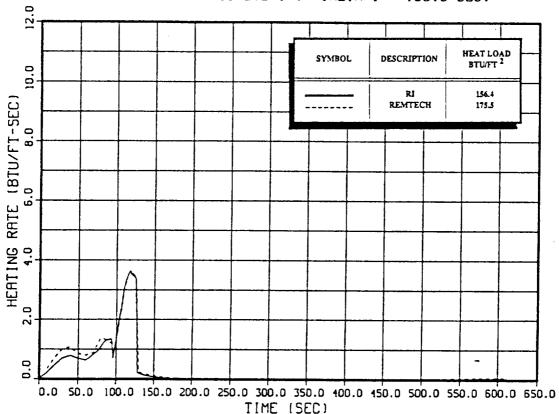


BODY POINT 7837 LH2 TANK XT - 1872.2 IN. THETA T - 225.0 DEG.

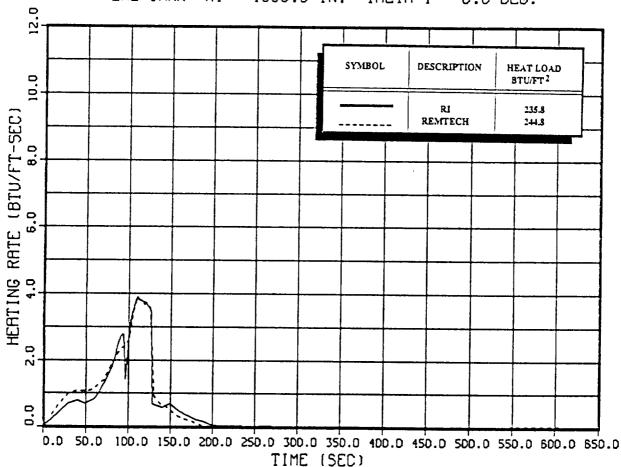


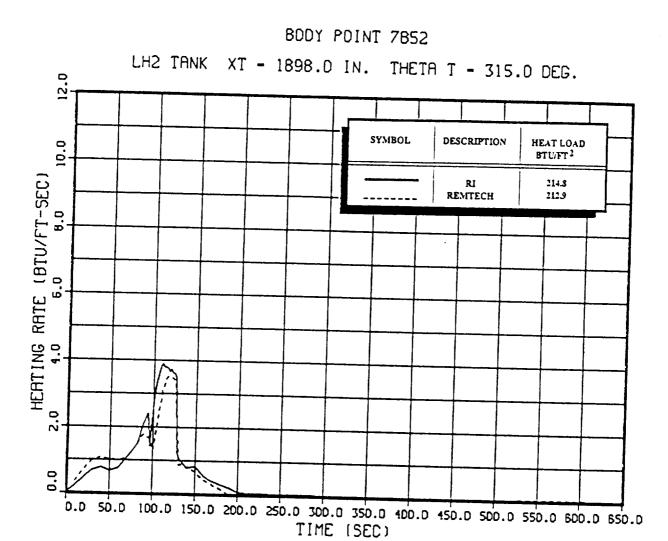
BODY POINT 7839

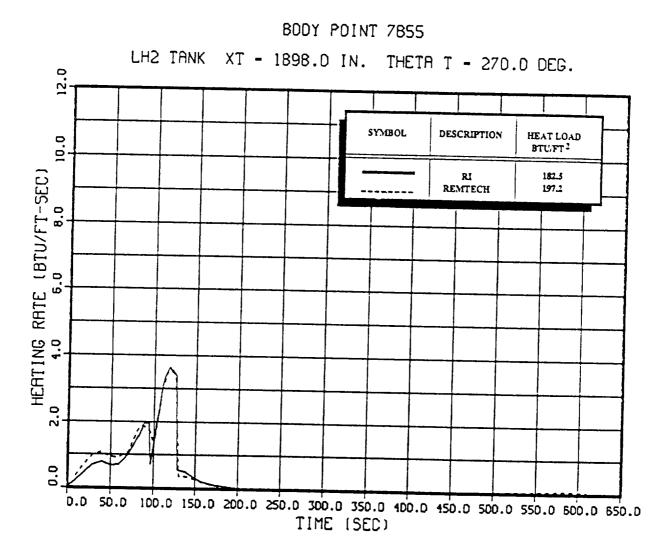




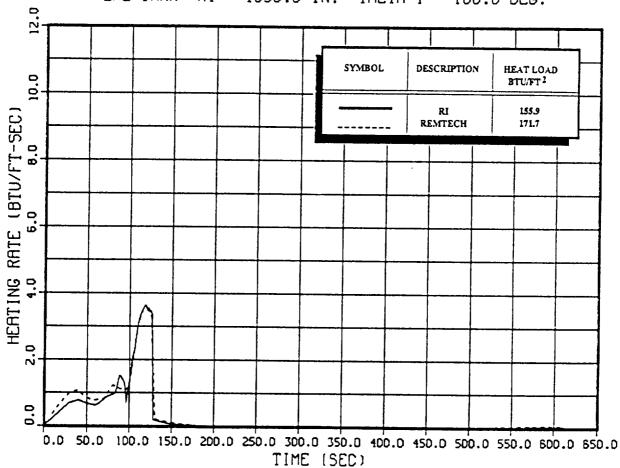
BODY PDINT 7850 LH2 TANK XT - 1898.0 IN. THETA T - 0.0 DEG.



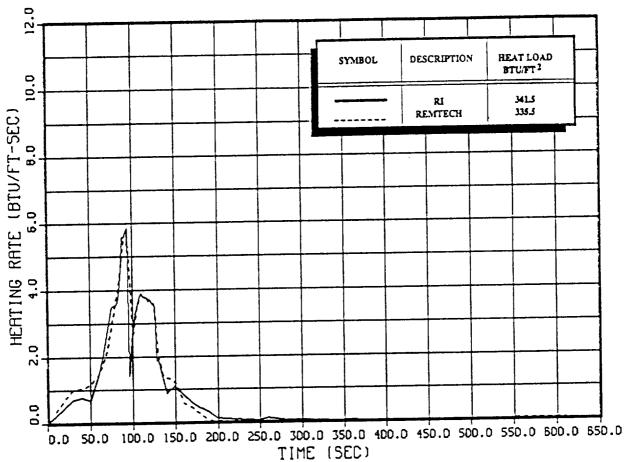




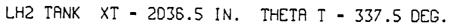
BODY POINT 7859 LH2 TANK XT - 1898.D IN. THETA T - 180.D DEG.

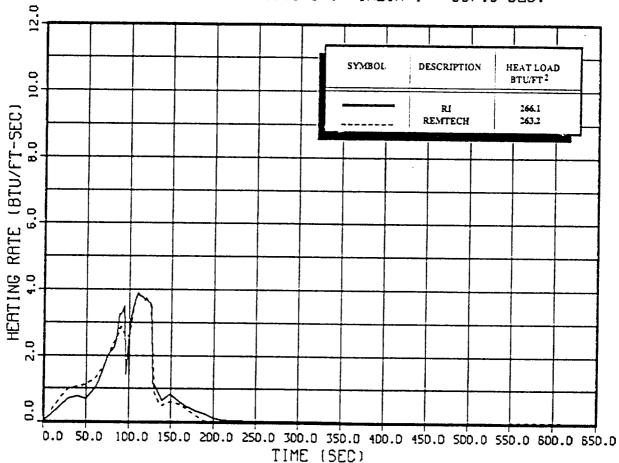


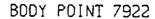
BODY POINT 7920 LH2 TANK XT - 2036.5 IN. THETA T - 0.0 DEG.

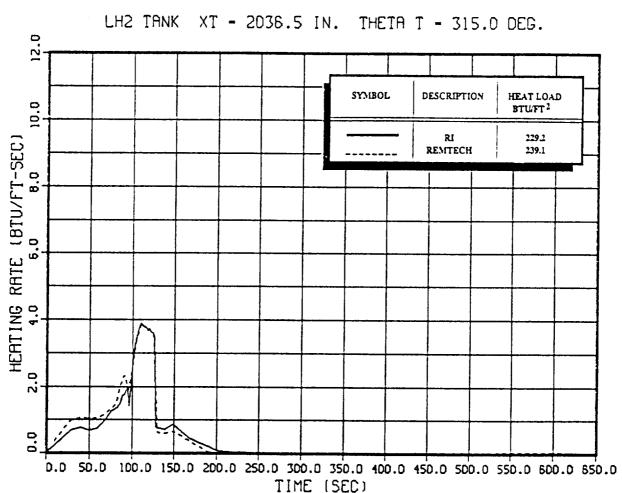


BODY POINT 7921

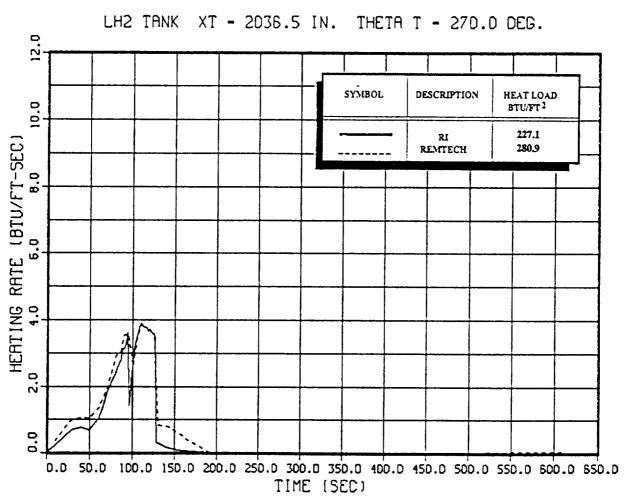






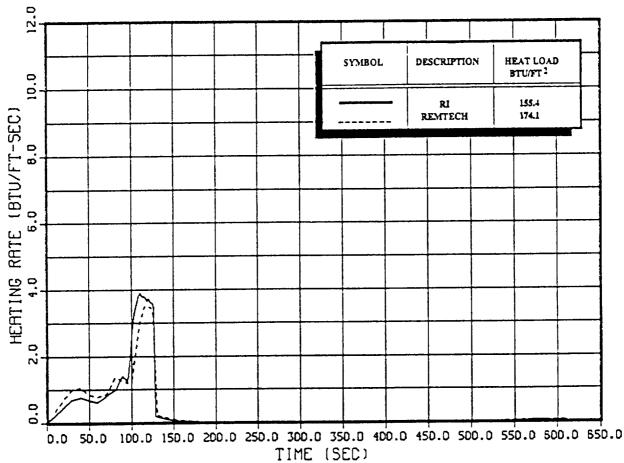


BODY POINT 7925

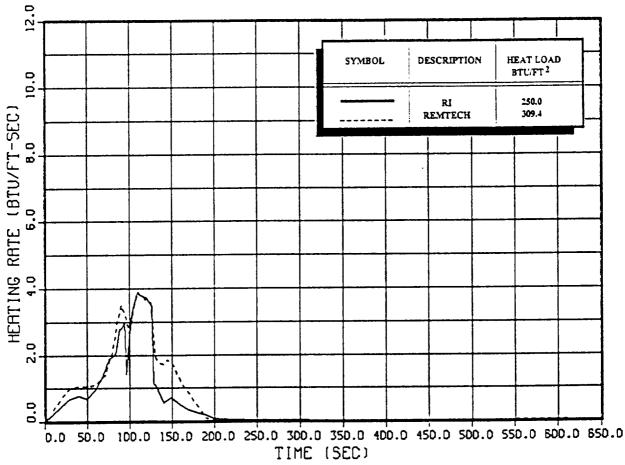


BODY POINT 7929

LH2 TANK XT - 2036.5 IN. THETA T - 180.0 DEG.

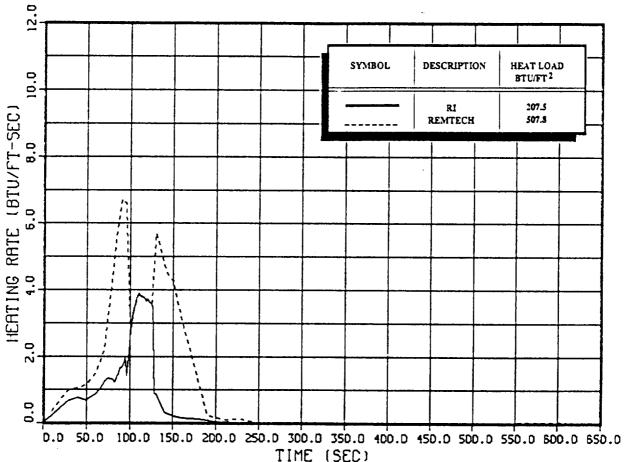


BODY POINT 7930 LH2 TANK XT - 2058.0 IN. THETA T - 0.0 DEG.



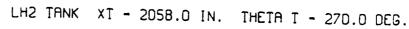
BODY POINT 7931

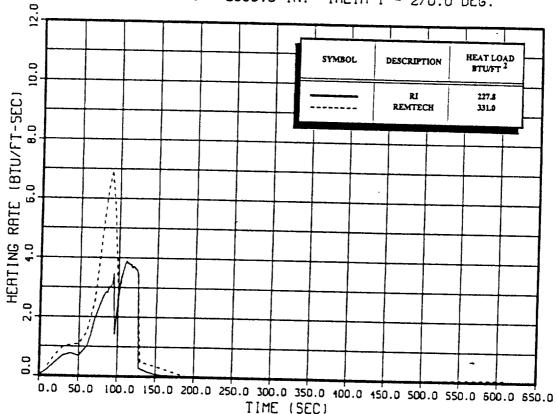
LH2 TANK XT - 2058.D IN. THETA T - 337.5 DEG.



- RI IVBC-3 environment considered low. Body point 7931 is located in front of the LHZ feed line; consequently, the separation would drive the aero convection up over the clean skin acerage level. Comparison of the IVBC-3 interference factors with the IH-97 data base (T/C 5052) show that the cold wall heating rates in the environment are low.
- Possible TPS impact.

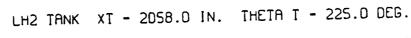
BODY POINT 7935

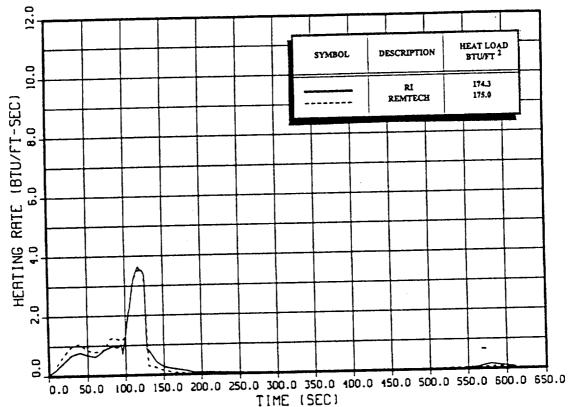




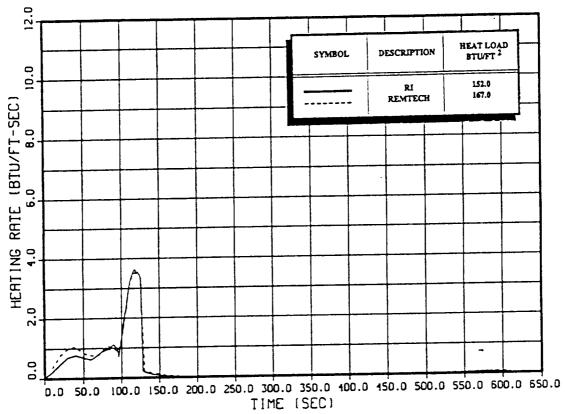
- $\bullet$  RI IVBC-3 environment considered low. Comparison of IVBC-3 interference factors with the IH-97 data base (T/C 5051) show that the cold wall heating rates are low in the M  $_{\infty}$  = 3 range.
- Possible TPS impact.

BODY POINT 7937



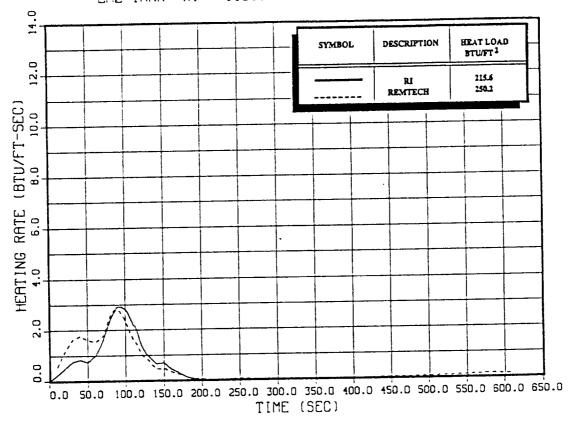


BODY POINT 7939 LH2 TANK XT - 2058.0 IN. THETA T - 180.0 DEG.

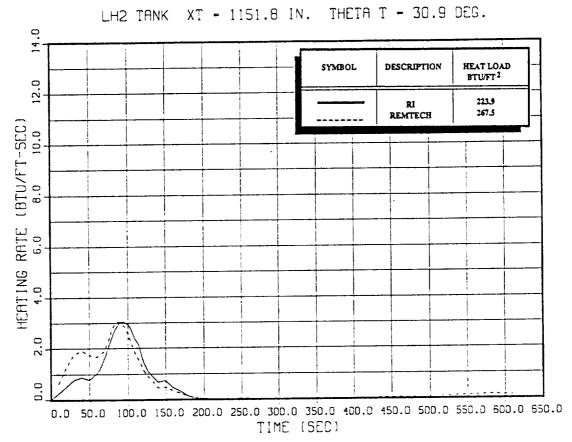


BODY POINT 50108

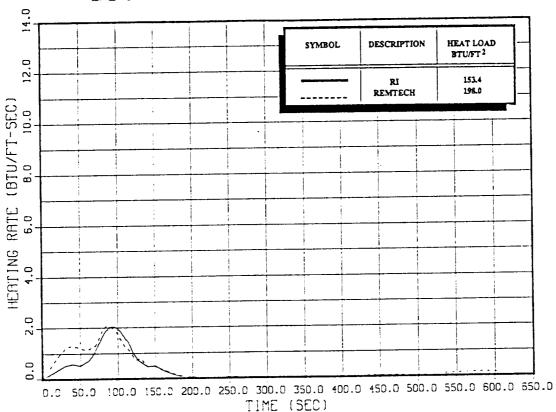
LH2 TANK XT = 1151.8 IN. THETA T = 30.9 DEG.



BODY POINT 50109

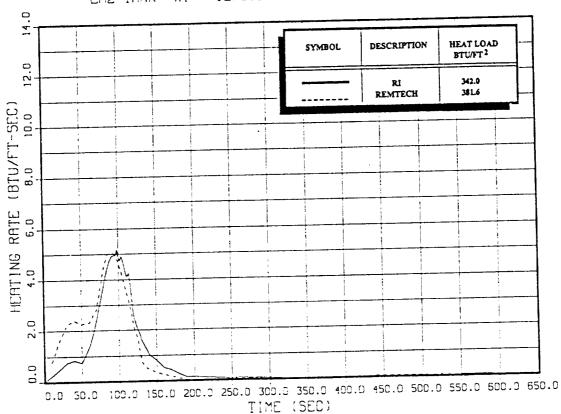


BODY POINT 50111 LH2 TANK XT = 1151.8 IN. THETA T = 30.9 DEG.



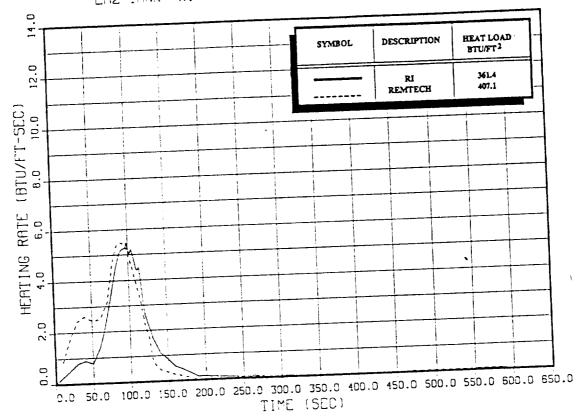
BODY POINT 50308

LH2 TANK XT = 1270.2 IN. THETA T = 30.9 DEG.

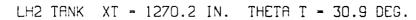


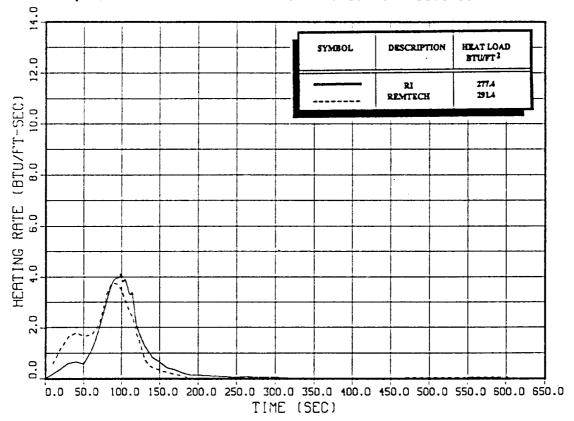
BODY POINT 50309

LH2 TANK XT = 1270.2 IN. THETA T = 30.9 DEG.



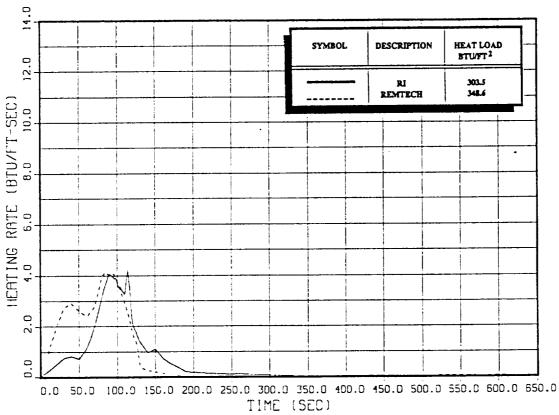
BODY POINT 50311



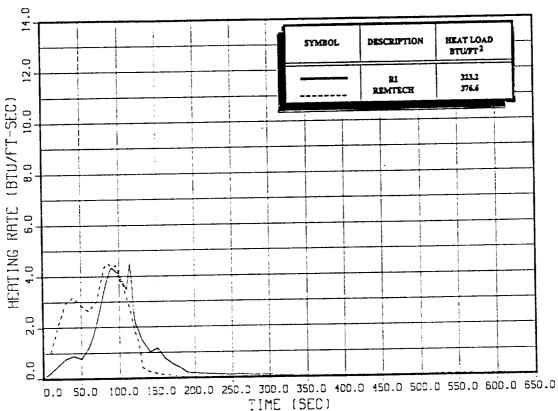


BODY POINT 50508

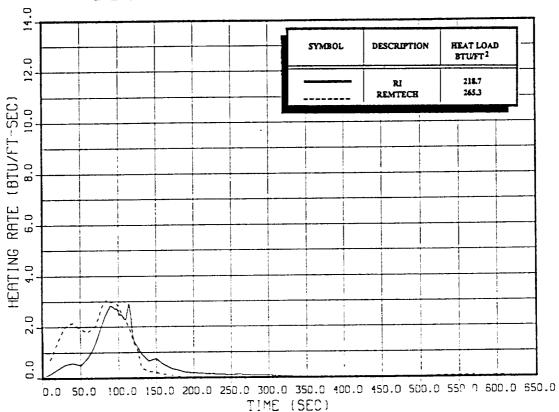
LH2 TANK XT = 1399.4 IN. THETA T = 30.9 DEG.



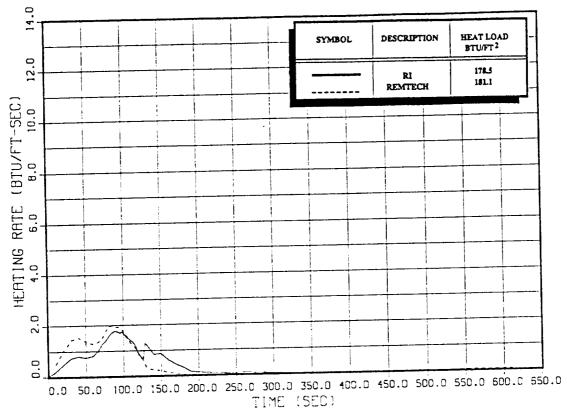
BODY POINT 50509 LH2 TANK XT = 1399.4 IN. THETA T = 30.9 DEG.



BODY POINT 50511 LH2 TANK XT - 1399.4 IN. THETA T - 30.9 DEG.

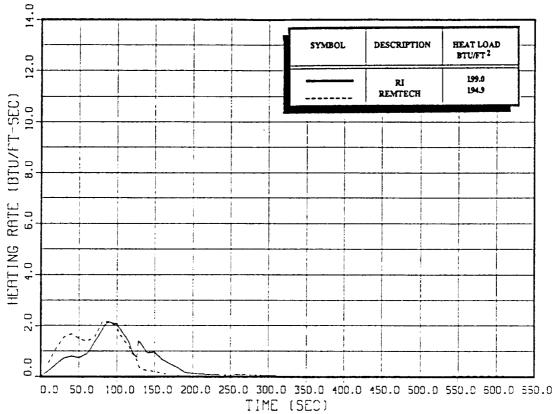


BODY POINT 50808 LH2 TANK XT = 1593.2 IN. THETA T = 30.9 DEG.

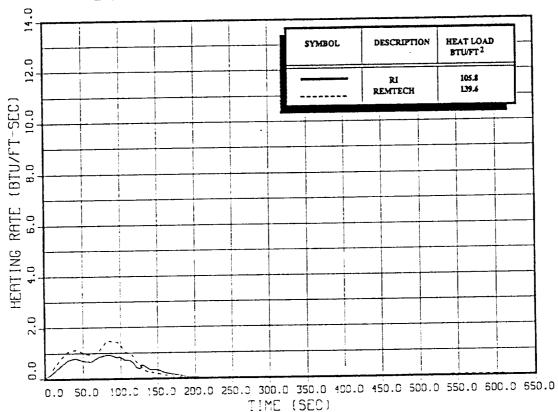


BODY POINT 50809

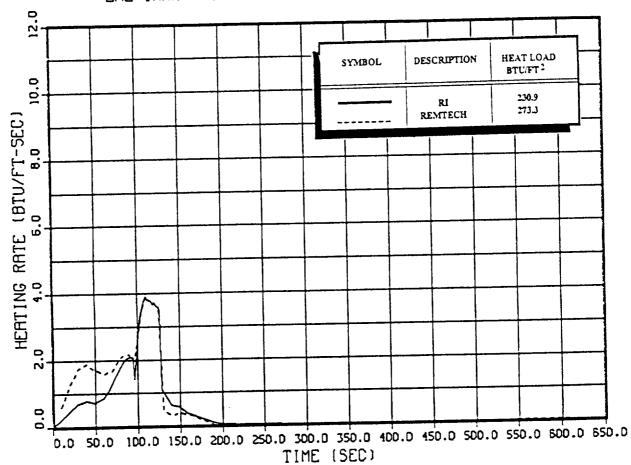
LH2 TANK XT - 1593.2 IN. THETA T - 30.9 DEG.



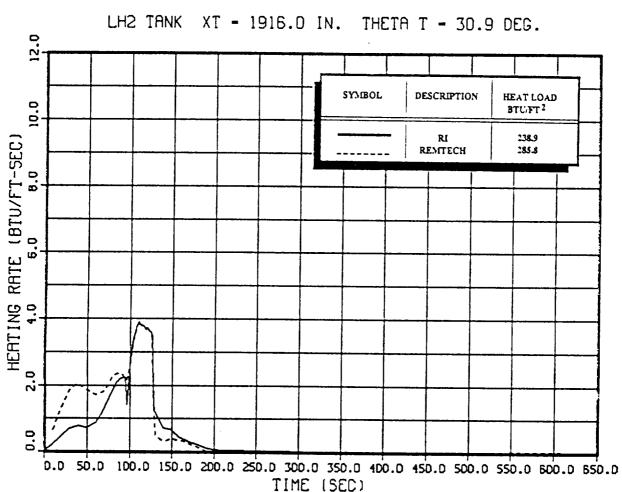
BODY POINT 50811 LH2 TANK XT = 1593.2 IN. THETA T = 30.9 DEG.



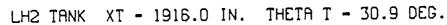
BODY POINT 51308 LH2 TANK XT - 1916.0 IN. THETA T - 30.9 DEG.

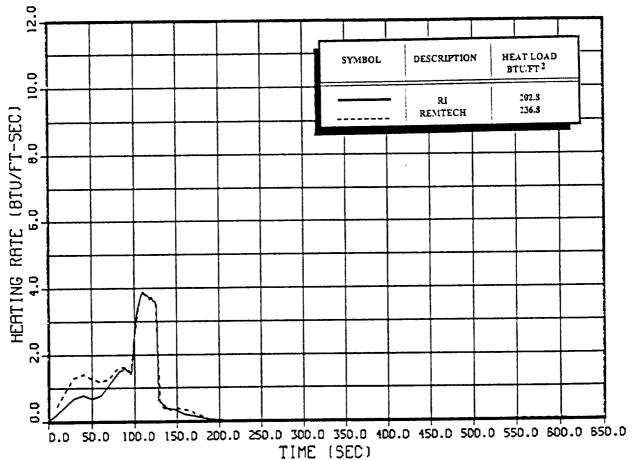


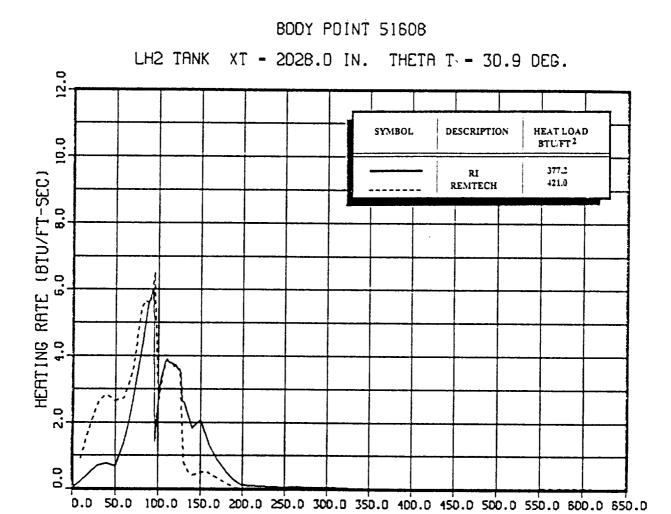




BODY POINT 51311



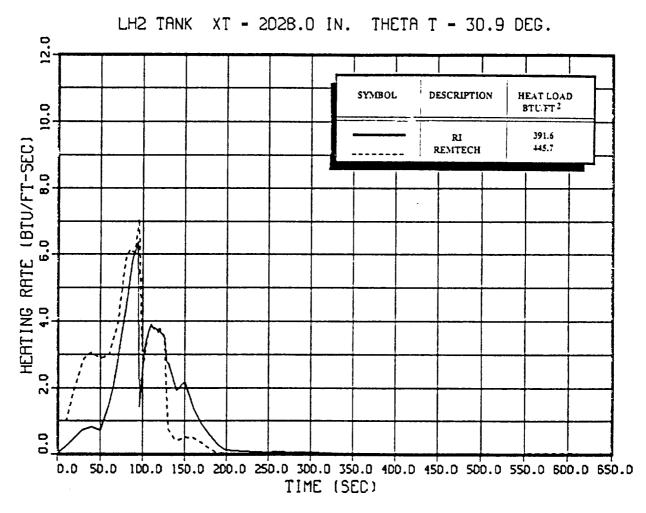




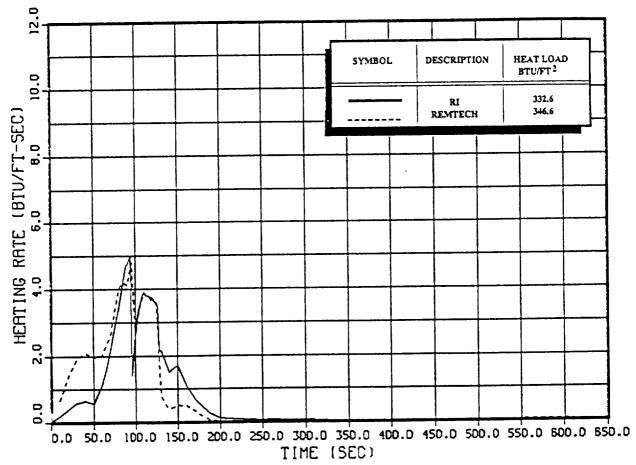
TIME (SEC)

Agreement is acceptable; no TPS impact.

BODY POINT 51609



BODY POINT 51611 LH2 TANK XT - 2028.0 IN. THETA T - 30.9 DEG.



BODY POINT 56283



